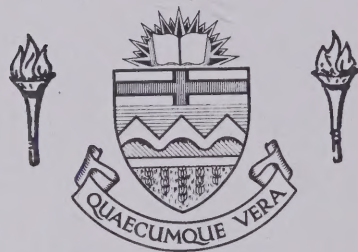


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LEFT-RIGHT DISCRIMINATION, LATERAL DOMINANCE

AND READING ACHIEVEMENT IN

GRADE I CHILDREN

BY



JOHN WILLIAM ALEXANDER SMITH

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled Left-Right Discrimination, Lateral Dominance and Reading Achievement in Grade I Children, submitted by John William Alexander Smith in partial fulfillment of the requirements for the degree of Master of Education.

ABSTRACT

This study investigated the relationship between left-right discrimination and reading achievement in a sample of sixty grade one children. The association of left-right discrimination with lateral dominance and the influence of lateral dominance on reading achievement were also examined. The nature of left-right discrimination and lateral dominance was explored by looking at their relationship with verbal, and visual perceptual skills in the sample.

Two tests were used to assess the ability to discriminate left and right - the Benton Test of Right Left Discrimination, a test which relies on the use of the terms "left" and "right", and the Non-Verbal Test of Directional Orientation, an experimental test which attempted to assess left-right orientation without the use of the labels "left" and "right". The Neale Analysis of Reading Ability was used to assess reading achievement while verbal ability was assessed by the vocabulary subtest of the Wechsler Intelligence Scale for Children (W.I.S.C.). The instrument used to measure perceptual skills was the Frostig Developmental Tests of Visual Perception.

A positive relationship between reading achievement and awareness of left and right was found. Children who were able to distinguish between left and right did better on a reading achievement test than those who were confused, even after verbal ability (as measured by the vocabulary subtest) was partialled out of left-right discrimination by covariance.

The Harris Tests of Lateral Dominance were used to establish the child's laterality status. It was found that established dominant subjects

(those who consistently used one side of the body) were better discriminators of left and right than were crossed dominant subjects. There were no significant relationships between lateral dominance status and reading. Hence it was argued that the preferential use of one side of the body affects the development of left-right awareness which in turn affects reading.

Left-right discrimination appears to be both verbal and a perceptual skill since good discriminators of left and right tended to be higher scorers on the verbal and visual perceptual tests. Lateral dominance, however, appears to be linked to visual perception, but not to verbal ability since established dominant subjects did better than crossed dominant subjects on the perceptual test but not on the verbal test.

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CHAPTER I

THE PROBLEM

One of the perceptual skills which the beginning reader must master is the law of directional constancy - the law which states that a letter or a word, to retain its name and meaning, must always be directionally oriented in the same way (Money, 1966, p. 22). The everyday perceptions of the young child have not taught him to look in an ordered way from left to right. When he looks at a car it is irrelevant whether he scans it from right to left or from left to right. In other words, objects have the same meaning and designation regardless of their orientation. Money refers to this phenomenon as "object-constancy".

Learning to read turns the prereader's conceptual world of object constancy into chaos, for it supplements the law of object constancy with the law of directional constancy...(Money, 1966, p. 22).

It seems that perception of correct order is basic to reading and that difficulty in attaining this skill may give rise to difficulties in learning to read (Vernon, 1957, p. 19).

Originally the issue of left-right awareness was of interest to psychologists, neurologists and reading clinicians because of its supposed relationship to anomalies of dominance. Interest in a link between lateral dominance and reading ability began in the nineteen twenties with the publication of Orton's work (1928). He proposed that children who experienced difficulties in reading would tend to show Crossed Dominance - that is they would use the opposite eye to their preferred hand - or Incomplete Dominance. Very few studies have been found, however, which investigated the relationship of left-right awareness and reading

achievement, and fewer studies still were located which sought to determine the relationship between left-right awareness and lateral dominance.

The main purpose of this study was to explore the relationship between left-right awareness and reading achievement, and between lateral dominance and reading achievement in first grade readers. The question of whether any aspect of lateral dominance is related to children's ability to discriminate left from right was examined. In addition the nature of lateral dominance and left-right discrimination was investigated by comparing the verbal and visual-perceptual abilities of children classified according to the type of laterality they possessed (established, mixed or incomplete), and according to whether they had developed an awareness of left and right or whether they were confused in this particular skill.

I. Background to the Problem

Left-Right Discrimination

The ability to discriminate left from right is by no means a simple skill. Vernon (1957) found that children observe and remember the orientation of shapes only with difficulty. Fellows (1968) highlights the importance of the discrimination of differently oriented forms:

It is puzzling because it is a discriminatory skill which seems to lag behind the development of visual space perception in general. It is, however, a skill of some importance, particularly for humans since it is absolutely necessary for adequate performance of certain socially essential tasks, such as reading and writing (p. 115).

Fellows goes on to emphasize the difficulty of the task of

discriminating right and left. He cites the fact that children learning to read typically make errors of reversal in the lower case letters such as 'd' and 'b'. The incidence of reversal errors appears to be greatest at about six years and falls off towards the age of nine or ten (Fellows, p. 119). It seems that the acquisition of left-right awareness during development parallels the diminishing occurrence of reversal errors in reading. However, Krise (1952), in a study of adults between the ages of twenty-nine and fifty-two years who had no neurological impairment and who were average readers, found that while none of them made reversals on letters, all of them made reversals on unfamiliar experimental visual symbols. This study indicates that if symbols are sufficiently unfamiliar, reversals may be made, even in subjects who have presumably attained left-right discrimination.

Piaget (1928) found that the development of left-right awareness occurred in three stages. At the first stage (five to eight years), the child is able to identify left and right on his own body; in the second stage (eight to eleven years) he is able to distinguish left and right on another person; at the third, most advanced stage (eleven to twelve years) left and right can be considered from the point of view of objects themselves. Swanson and Benton (1955) studied the development of left-right awareness in children between the ages of five and one half years and nine and one half years. At age six the children performed at slightly better than chance level whereas at age nine the children made very few errors even on difficult tasks of identifying the lateral body parts of a picture of a man. They conclude that the development of left-right discrimination begins at about five years and reaches maturity at about twelve years.

Wapner and Cirillo (1968) demonstrated that as children get older they become able to internalize left-right relations so that they can coordinate their own perspective with that of a model. In a task which involved copying a model as he touched objects or body parts with his right or left hand, Wapner and Cirillo found that younger children tended to make mirroring and object-mirroring responses while older children were much more able to make transposition responses. Marked developmental changes in left-right discrimination, according to this study, can occur as late as twelve to fourteen years. The important thing which younger children lack in the task of transposing left-right relations according to the authors, is the ability to internalize the left-right distinction and to coordinate their own movements with that of a model.

That left-right awareness is not purely a visual perceptual skill but also involves symbolic ability is suggested by several authors. Fellows (p. 120) regards the ability to identify right and left as an associational or conceptual problem for the young child, while Vernon (1957, p. 54) states that the inability of the backward reader to discriminate orientation and order in shapes "is probably a cognitive rather than a perceptual disability". The task of discriminating right and left, in Templeton's (1966) view, involves not only perceptual discrimination but verbal ability.

Both Piaget (1928) and Werner (1948) regard the development of left-right awareness as an essential element in the desubjectification of thought. The child must represent to himself viewpoints other than his own at stage two and stage three, whereas at stage one the notion of left-right is absolute rather than relative. Templeton (1966) points

out that left-right discrimination is unique among other spatial concepts such as north-south or up-down because it begins with an ego-centric reference point. The growth of left-right awareness is concomitant with an increasing distance from self, the internalization of actions, and an ability to deal with abstract relationships on the representational level.

The symbolic function thus evolved facilitates the acquisition of language or a system of collective signs. Hence from being purely perceptual, space has become partly representational ... (Piaget and Inhelder, 1963, p. 12).

Piagetian theory then, indicates that stable conceptions of directionality as reflected in stage three of left-right awareness indicate an ability to transcend the field of direct perception and manipulate symbols on an abstract relational level. From this point of view reading can be related to left-right awareness, not only because both processes require the perceptual ability to scan according to the law of directionality, but because both processes involve the conceptual ability to understand and handle symbols on a level which goes beyond sensory data. Semelmeyer (1957) argues that reading should bear the same relationship to experiences or events that a map bears to the territory which it is supposed to represent. In a similar fashion, the concept of directionality embodied in the awareness of left and right is an abstraction based on the topological relationships of objects in space (Piaget and Inhelder, 1963).

Benton's investigations led him to the view that the nature of left-right awareness evolves during development from being primarily a perceptual ability to becoming a verbally based skill. The earliest form of left-right discrimination according to Benton (1959) is an

essential component of differentiation of body schema in the form of a "right-left gradient". This gradient is thought to be based on somesthetic and visual perceptual skills. The link between laterality or peripheral dominance and left-right discrimination seems to be based on the assumed connection of both to the preferred use of one side of the body. Templeton (1966) argues that a hand preference for a particular task implies left-right discrimination. Benton and Menefee (1957) suggest that "perceptual (right-left) discrimination develops out of and is in part determined by, differential motor usage of the two hands" (p. 237 - 238). They expect that a preference for one side of the body will be paired with less confusion between right and left.

If left-right discrimination and lateral dominance are related the literature would suggest that a relationship would be most likely to appear in younger children. Benton and Kemble (1960) express the view that the left-right gradient is important mainly for the most elementary form of left-right orientation, the child's ability to discriminate consistently right and left on his own body (Piaget's Stage 1). They view symbolic factors as essential to the development of left-right awareness beyond this basic level. Children who show systematic reversal in left-right awareness are hypothesized by Benton and Kemble to be retarded in the development of language skills. Piaget would, no doubt, agree that the latter was true but would likely argue that the symbolic deficit was a result rather than a cause of confusion in left-right awareness. While the present study will not be able to resolve the issue of cause and effect, the inclusion of measures of visual perceptual and language ability should at least indicate whether a relationship exists between these two skills and left-right awareness.

It seems most likely that measures of perception will relate more closely to the left-right discrimination in the present study because it deals with Grade One children who are most likely to be at stage one of left-right discrimination.

Peripheral and Central Dominance

Apart from their possible role as factors in the growth of left-right discrimination, measures of hand, eye and foot preference are relevant to Orton's neurologically based theory of reading disability.

It has been known for some time that in humans one side of the brain predominates in the control of speech and language (Hecaen and de Ajuriaguerra, 1964, p. 36). This phenomenon is known as cerebral dominance. The observation that aphasias frequently resulted from left hemispheric lesions led to the discovery of cerebral dominance (Benton, p. 335). The hemisphere in which the language centre is located is called the "dominant" hemisphere. Cerebral dominance is not present in infancy, and is thought to appear some time after the age of two (Lenneberg, 1967, p. 151). Left-sided cerebral dominance is more common than right dominance as is illustrated by the fact that left hemispheric lesions result in speech disturbance eighty-five percent of the time while right hemispheric lesions disturb speech forty-five percent of the time. (Lenneberg, 1967).

An interest in the phenomenon of motor preference in connection with language skills such as reading and writing arose out of the hypothesis that these functions were also represented in the brain unilaterally in the dominant hemisphere. Orton (1947) took the view

that:

This concentration of the whole control of speech, reading and writing in one half of the brain bears an intimate relationship to the development of unilateral manual skill in the individual...(p. 27).

Unfortunately, the relationship between cerebral dominance and lateral preference is by no means as simple as it appears, or as Orton thought it was (Money, 1966; Benton, 1965; Hecaen and de Ajuriaguerra). As Lenneberg points out "hand preference is not an unfailing guide to knowledge about cerebral dominance" (1967, p. 177).

Mixed dominance is a term which covers both crossed and incomplete dominance (Harris, 1940, p. 250). Incomplete dominance occurs when there is no established preference for one side of the body in either hand, eye or foot, whereas crossed dominance means the use of the opposite hand, eye or foot. Mixed dominance has been regarded as of critical importance in symbolic disabilities such as reading retardation. One neurological view is that mixed dominance is an indication of lack of established cerebral dominance. According to Orton (1937) the development of an established dominance of one side of the brain is essential for learning to read, spell and write. Orton hypothesized that if an individual failed to develop a consistent dominance of one side of the brain, there would be conflict between the two hemispheres. One hemisphere, linguistically, is a mirror image of the other, in Orton's view. If dominance does not become established, reversals in reading will result from the rivalry between the two hemispheres.

Footedness and eyedness have also been associated with cerebral dominance but have been much less studied than handedness. Sidedness is

most frequently unilateral but very often the preferred eye and foot are on the opposite side to the preferred hand. According to Harris (1940, p. 240) in one out of three people the preferred eye is on the opposite side of the body to the preferred hand (crossed dominance). The frequent occurrence of crossed dominance may be a result of the greater susceptibility of handedness to social reinforcement, causing individuals with an innate tendency to left hand preference to adopt right handedness. Money claims (p. 31, 1966) that the inclusion of eyedness as a measure of lateral dominance is meaningless and unscientific as far as inferences about cerebral dominance are concerned, since each hemisphere of the brain receives part of the optic nerve as well as nerves from the eye muscles of both eyes.

Orton's theory currently enjoys little support among neurologists, psychologists (Fellows, 1968; Benton, 1965) or reading specialists (Zeman, 1967). Neither research connecting peripheral laterality and reading or advances in neurological knowledge offer much to support Orton, and much directly contradicts him. However, a discussion of Orton's viewpoint was felt by the writer to be necessary in a study of laterality and reading. A more intelligent approach is adopted by Spitzer, Rabkin and Kramer (1959)

If children with reading disabilities have a higher incidence of mixed dominance than the normal, some other explanation of this phenomenon is necessary (p. 77).

An alternative explanation for the existence of a link between lateral dominance and reading is that laterality indirectly affects reading through its influence on the development of directional discrimination. The laterality variable was included in the study because the

above rationale seemed to support a connection between laterality and left-right discrimination.

II. Definition of Terms

The following terms are used in this study.

Anomalies of Dominance refer to any kind of peripheral dominance other than established dominance.

Central Dominance refers to the control of certain body functions by one side of the brain.

Cerebral Dominance means the same as central dominance.

Confused is a term which has been used in this study to describe the status of subjects who do not have the ability to discriminate left from right on the Benton Test of Right-Left Discrimination or on the Non-Verbal Test of Directional Orientation. Subjects who scored between two and twenty-two on the Benton A; or who scored any errors on the Benton B and Benton C; or who scored below the median (twenty-two) on the Non-Verbal Test of Directional Orientation were considered Confused on each respective test.

Consistent is a term which has been used in this study to describe those subjects who elevated the same hand on the Extensibility test that was their preferred hand as indicated by the Harris Laterality Test.

Consistently Reversing is a term which has been used to describe those subjects who consistently called 'left' 'right', or 'right' 'left' on the Benton A - in other words subjects who scored between zero and two on the Benton A. The term denotes that subjects are able to discriminate left and right but do not have the appropriate label available.

Directionality Skill is the ability to discriminate and perceive

directions.

Discriminating is a term used to describe the status of subjects who were not confused on the Benton A, Benton B, Benton C or the Non-Verbal Test of Directional Orientation. That is they receive scores of between twenty-two and twenty-four on the Benton A; score no errors on the Benton B or Benton C; or score above the median (twenty-two) on the Non-Verbal Test of Directional Orientation.

Dominance or Lateral Dominance - unless qualified this term is taken to mean peripheral dominance. It denotes the preferential use and/or greater skill of the lateral body parts (See Preferred Hand).

Established Lateral Dominance indicates the consistent use of one side of the body. In this study established lateral dominance was indicated when subjects used one hand for eight or more out of ten of the Harris Tests of Lateral Dominance handedness tasks, the same hand for the two eyedness tasks and the same foot for the two footedness tasks.

Incomplete Dominance exists when the individual does not show a consistent preference for one eye, hand or foot. For example an individual was classified as incomplete dominant with respect to handedness if he used any one hand less than eight times on the Harris Tests of Lateral Dominance handedness tasks, incomplete dominant with respect to footedness if he used different feet for the two footedness tasks; incomplete dominant with respect to eyedness if he used different eyes for the two eyedness tasks.

Inconsistent is a term which has been used in this study to describe subjects who elevated a different hand on the Extensibility Test than their preferred hand.

Laterality refers to the preference or superiority of one side

of the body over the other in performing motor tasks.

Mixed Dominance is a term which included both crossed dominance and incomplete dominance.

Non-Verbal Directional Orientation Ability refers to the subjects ability to discriminate directions without labels as measured by his score on the Non-Verbal Test of Directional Orientation.

Peripheral Dominance and Peripheral Laterality are alternative terms for lateral dominance.

Preferred Hand denotes the hand which the subject used for eight or more out of ten of the items on the handedness tests in the Harris Tests of Lateral Dominance.

Reading Achievement in this study is taken to be the subjects Accuracy score on the Neale Analysis of Reading Ability.

Reversals refers to the left-right rotation of letters or words eg. 'b' for 'd' or 'was' for 'saw'.

Left-Right Awareness refers to the ability of an individual to distinguish between right and left. It has various levels of sophistication which are measured in this study by the Benton Tests of Right-Left Discrimination.

Left-Right Discrimination is another term for Left-Right awareness.

Unilateral Dominance is a synonym for established dominance.

Verbal Ability is the subject's score on the vocabulary subtest of the Wechsler Intelligence Scale for Children.

Visual Perceptual Ability in this study refers to the subject's scores on the Frostig Developmental Test of Visual Perception.

IV. HYPOTHESES

Research Hypothesis 1

Grade one children who are not confused in discrimination between right and left will be more successful in reading than children who are confused in left-right discrimination.

Null Hypotheses

A. There is no significant correlation between scores on the Neale Analysis of Reading Ability and:

- a) Scores on the Benton Test of Right-Left Discrimination.
- b) Scores on the Non-Verbal Test of Directional Orientation.

B. There is no significant difference between the Neale scores of:

- a) Confused, Discriminating or Consistently Reversing subjects on the Benton A.
- b) Confused and Discriminating subjects on the Benton B.
- c) Confused and Discriminating subjects on the Benton C.
- d) Confused and Discriminating subjects on the Non-Verbal Test.

C. There is no significant difference between the Benton scores of subjects who make reversal errors on the Neale and those who do not.

D. There is no significant difference in the Non-Verbal scores of subjects who make reversal errors on the Neale and those who do not.

Research Hypothesis 2

Grade one children who are not confused in discrimination between right and left will score higher on visual-perceptual skills than those who are confused.

Null Hypotheses

A. There is no significant correlation between Frostig scores and:

- a) Benton scores
- b) Non-Verbal scores

B. There is no significant difference between the Frostig scores of:

- a) Confused, Discriminating and Consistently Reversing subjects on the Benton A.
- b) Confused and Discriminating subjects on the Benton B.
- c) Confused and Discriminating subjects on the Benton C.
- d) Confused and Discriminating subjects on the Non-Verbal test.

Research Hypothesis 3

Grade one children who are not confused in discrimination between right and left will score higher on verbal ability than those who are confused.

Null Hypotheses

A. There is no significant correlation between W.I.S.C.

vocabulary scores and:

- a) Benton scores
- b) Non-Verbal scores

B. There is no significant difference between the W.I.S.C.

vocabulary scores of:

- a) Confused and Discriminating subjects on the Benton A.
- b) Confused and Discriminating subjects on the Benton B.
- c) Confused and Discriminating subjects on the Benton C.
- d) Confused and Discriminating subjects on the Non-Verbal

test.

Research Hypothesis 4

Grade one children who are not confused in verbal left-right discrimination will have a greater competence in non-verbal left-right discrimination than those who are confused.

Null Hypothesis

There is no significant correlation between Benton and Non-Verbal test scores.

Research Hypothesis 5

Grade one children who do not have established lateral dominance will be less successful at reading than those who do.

Null Hypotheses

A. There is no significant difference in the Neale scores of subjects who have Crossed Dominance and subjects who have Established

Dominance.

B. There is no significant difference in the Neale scores of subjects who have Incomplete Dominance and subjects who have Established Dominance.

C. There is no significant difference in the Neale scores of subjects who are Consistent and Inconsistent on the Extensibility test.

D. There is no significant difference in the proportion of subjects who have Crossed Dominance and make reversal errors and the proportion of subjects who have Established Dominance and make reversal errors.

E. There is no significant difference in the proportion of subjects who have Incomplete Dominance and make reversal errors and the proportion of subjects who have Established Dominance and make reversal errors.

F. There is no significant difference in the proportion of subjects who are Consistent on the Extensibility test and make reversal errors and the proportion of subjects who are Inconsistent and make reversal errors.

Research Hypothesis 6

Grade one children who do not have Established lateral dominance will show greater confusion in left-right discrimination than those children who do not have Established dominance.

Null Hypotheses

A. There is no significant difference between the means of the

Established and Crossed Dominant subjects on:

- a) The Benton
- b) The Non-Verbal

B. There is no significant difference between the proportion of Incomplete and Established dominant subjects who are:

- a) Discriminating, Confused or Consistently Reversing on the Benton A.
- b) Discriminating or Confused on the Benton B.
- c) Discriminating or Confused on the Benton C.
- d) Discriminating or Confused on the Non-Verbal test.

Research Hypothesis 7

Grade one children who do not have Established Dominance will score lower on Visual-Perceptual abilities than those who do.

Null Hypotheses

- A. There is no significant difference in the Frostig scores of:
 - a) Subjects who have Crossed Dominance and subjects who have Established Dominance.
 - b) Subjects who have Incomplete Dominance and subjects who have Established Dominance.
 - c) Subjects who are Consistent on the Extensibility test and subjects who are Inconsistent.

Research Hypothesis 8

Grade one children who do not have Established Dominance will score lower on verbal ability than those who do.

A. There is no significant difference in the W.I.S.C. vocabulary scores of:

a) Subjects who have Crossed Dominance and subjects who have Established Dominance.

b) Subjects who have Incomplete Dominance and subjects who have Established Dominance.

c) Subjects who are Consistent on the Extensibility test and subjects who are Inconsistent.

Summary

This chapter defined the problem to be explored in this study, namely the relationship between:

- a) Left-right discrimination and reading achievement.
- b) Lateral dominance and reading achievement.
- c) Lateral dominance and left-right discrimination, and
- d) The possible verbal or visual-perceptual nature of left-right discrimination and lateral dominance.

A rationale was presented which indicated that left-right discrimination is a complex developmental task. It evolves from being a relatively simple perceptual skill at age five to eight to becoming an abstract verbal skill at age eleven to twelve. It was argued that left-right discrimination was related to reading for two possible reasons. First that it is necessary to learn the law of directional constancy in order to

achieve in reading and second that both reading and left-right discrimination are abstract symbolic skills at the more advanced level.

The theory that lack of established cerebral dominance leads to problems in reading was discussed and some criticisms were presented. It was suggested that it was reasonable to assume that a strong preference for one side of the body could lead to better left-right discrimination and hence to greater competence in reading.

The remainder of the chapter dealt with definitions of terms and hypotheses to be tested.

CHAPTER II

REVIEW OF RESEARCH

This chapter contains a review of research dealing with left-right discrimination and reading; lateral dominance and left-right discrimination; lateral dominance and reading achievement.

Left-Right Discrimination and Reading

The research which has been carried out on left-right awareness has generally shown a higher incidence of confusion in left-right discrimination amongst poor readers than in good readers. Frequently, however, the main focus of the studies has been to show a relationship between established lateral dominance and reading skill while interest in left-right discrimination has been secondary. There has been only one study on left-right awareness in beginning readers. Another aspect of research in this area which restricts its generalizability is that samples have usually been taken from selected clinic populations.

Harris (1957) compared 316 clinical cases of reading disability with 245 normal children between the ages of seven and eleven and a half. He found a significantly larger degree of confusion in identifying left and right among the retarded readers. Unfortunately the only basis for measuring left-right awareness appears to have been the three items on the Harris Test of Lateral Dominance which require the child to identify his right hand, left ear, and right eye. Such a small number of items hardly seems a reliable test of left-right discrimination and leaves

unmeasured more advanced stages in left-right awareness.

In a detailed study of the neurological and perceptual characteristics of a sample of 150 children (between the ages of eight years and six months and fourteen years) seen at a hospital clinic for reading problems, compared with thirty normal controls, Silver and Hagin (1960) found a significantly higher incidence of defects of left-right discrimination (ninety-two percent) amongst the underachieving children than in the control children. The fact that no description of the test for left-right discrimination was included makes it difficult to evaluate this study.

Benton and Kemble (1960) compared twenty severely retarded readers receiving remediation at a university clinic with twenty average readers. The age range of the children was from seven years and ten months to ten years and five months. The test battery which was developed by Benton has the advantage of established reliability (Swanson and Benton, 1955). The study indicated that children with reading disability tend to be poorer in all aspects of left-right discrimination than normal children of similar age and intelligence. However, the observed differences were not very large and did not all reach statistical significance.

One study which did not find a significant relationship between reading retardation and left-right discrimination was done by Coleman and Deutsch (1964). The subjects in this study were eighty-six children involved in a school remedial reading program and thirty normal readers between the ages of nine years and five months and twelve years and three months. The subjects represent a somewhat atypical population since they were almost all negroes from low socioeconomic status backgrounds. Normal

readers performed significantly better on the Benton Right-Left Discrimination test than did retarded readers. However, the groups did not differ significantly when intelligence was taken into account (by covariance).

Belmont and Birch (1965) in a study of 150 nine and ten year-olds, both normal and retarded readers, found the retarded readers contained a significantly greater proportion of children who were unable to identify left and right on their own bodies and in the general environment. The test used was Piaget's original (1928) scale.

Monk (1967) found a significantly greater number of reading reversals in grade two children who made more left-right discrimination errors. The greatest number of reading reversals occurred for children who showed systematic confusion between right and left (i.e. always said right for left and vice versa) which indicates the importance of verbal ability in left-right discrimination.

Cohen and Glass (1968) showed a positive relationship existed between left-right awareness and reading performance in first grade children. The authors used a large sample (120) but did not report which tests were used to measure left-right awareness or reading. It was interesting to note that such a relationship was not found in grade four children. In other words, by the time the poor reader reached grade four, while his reading ability had not improved, he had acquired the concept of left-right awareness. The authors took this finding as evidence that left-right discrimination was particularly important for beginning readers and felt that early failure due to a lack in this ability to discriminate might condition the child's attitude to reading and lead to continued failure.

Netzer (1969) observed significant differences between thirty good readers and thirty poor readers from grade one on the task of sequence discrimination. She also found significant relationship between verbal competence as measured by the vocabulary sub-test of the Wechsler Intelligence Scale for Children and the perceptual tasks of position discrimination and sequence discrimination.

Lateral Dominance and Reading

The relationship between lateral dominance and reading achievement seems to be one of the most widely researched areas in the field of reading. For example in Johnson's (1957) comprehensive review of literature on reading disability, almost a third of her references relate to the problem of central and peripheral dominance. The present review of the literature is not intended to be exhaustive but deals with a representative selection of the more recent studies in the area.

Before looking at individual studies in detail an overview may be obtained by looking at two literature reviews in the area. Johnson (1957) found that thirteen out of fifteen studies showed that no particular handedness was found with greater frequency among reading disability cases than among average readers. She concludes that "left-handedness or confusion in handedness alone does not appear to be a significant factor in reading disability" (p. 9). Johnson found only three out of nine studies supported a relationship between eye dominance and reading ability. Although this is somewhat more promising than the handedness studies, Johnson considers the evidence not strong enough to support the theory that eye dominance alone is a reliable indicator of reading achievement. Finally Johnson mentions five studies of crossed

dominance and reading achievement, and reports that none of them indicated a significantly greater frequency of crossed dominance in poor readers. However, a number of authors were cited whose clinical opinion favoured the importance of crossed dominance in reading problems. In general Johnson's review fails to support a definite relationship between dominance and reading.

In a more recent review Zeman (1967) finds only two out of fourteen studies which show significant relationship between lateral preference and reading ability. The majority of the studies were either inconclusive or definitely negative. Zeman argues that "perhaps the research time that is being devoted to this area could be used more advantageously in studying other relationships in respect to reading" (p. 123).

Krise (1952) carried out a study which is most remarkable for the fact that it contradicts every other study in this area of which the present writer is aware. In a sample of twenty-nine adults who were normal readers Krise examined the relationship between tendency to commit errors of reversals and lateral preference. Reversal tendencies were measured by asking subjects to detect reversals in letters and in unfamiliar visual symbols. Krise found a significant positive correlation between unilateral eye-hand dominance and reversal tendency. In other words, the more the tendency to have unilateral preference the more likely the subject was to make reversal errors. This finding runs directly counter to the general line of evidence and Krise himself was at a loss to explain it.

Harris (1957) carried out an extensive study of laterality with a sample of 316 disabled readers and 245 unselected children between the

ages of seven and eleven plus. The disabled readers were clinical cases of marked reading disability. Harris used his own tests of lateral dominance. Amongst the seven year old children with reading difficulties Harris found forty percent had mixed hand dominance (incomplete dominance), a proportion nearly twice that in the unselected group. Twenty-five percent of the nine year-old reading problems had mixed hand dominance, three times the figure for the normal population. Harris did not, however, find any significant difference in crossed dominance, eye dominance or foot dominance among normal and retarded readers.

Spitzer, Rabkin and Kramer (1959) compared the dominance of 103 children with reading disability (their reading level was a year below what their intellectual capacity suggested it should be) and a control group of 288 normally reading children. The subjects ranged in age from five to thirteen. The number of incomplete and crossed dominant subjects was virtually identical in the experimental and control groups. The authors also survey other literature in the area and conclude that there is strong evidence against any relationship between mixed dominance and reading disability.

In a study of 150 children with "specific reading disability" Silver and Hagin (1960) found no greater incidence of right or left hand preference or ambilaterality in retarded readers than in a control group matched for sex, age and intelligence. Neither was any significant relationship found between eyedness, footedness or crossed dominance and reading problems. These results were replicated in a further study of 100 first and fourth grade children from suburban schools. Silver and Hagin also gave their subjects the Schilder extension test, which is a test

of cerebral dominance. Silver and Hagin found that in seventy-four percent of children with reading disability there was a discrepancy between the elevated hand on the extensibility test and the hand used for writing. The control group did not show a similar prevalence of discrepancies between the elevated hand and the preferred hand for writing. A further eighteen percent of the reading disability cases showed no elevation of either hand. Again the results were replicated on the 100 first and fourth graders, i.e. there were more discrepancies between the elevated and the preferred hand. The study seems to suggest that research using other methods of determining cerebral dominance besides lateral body preference may be fruitful. The authors claim that lateral preference is a poor measure of cerebral dominance. The conclusion of the study is that "the child with a reading disability is generally one who is right brain dominant, but who is now using his right hand for writing" (Silver and Hagin, p. 129).

Fleischer (1962) found no demonstrable effect of lateral dominance on reversals in reading in a study of 150 fourth grade children. No differences were found in the ability to perceive reversed symbols among subjects with crossed dominance and left or right unilateral dominance. The subjects in this study did not show any evidence of reading disability and were completely consistent in eye-hand preference (incomplete dominant subjects were excluded). That is all subjects used the same hand for all tasks given, the same eye for all the eyedness tasks given and the same foot for all the footedness tasks.

Koos (1964) tested some specific hypotheses relating certain aspects of laterality to reading retardation on a sample of 109 children from the primary grades. She hypothesized, on the basis of Orton's

writings, that the lack of a dominant eye in binocular vision was an important factor in causing reading failure. Koos's results indicated a positive relationship between the lack of a controlling eye and reading retardation in grade two children but not in grade one or three children. Orton's views about the link between eye preference and cerebral dominance are most dubious since both sides of the brain receive the optic nerve. Moreover Koos found that the lack of presence of a controlling eye was not independent of I.Q.- this may be a further cause of the inconsistent results.

Koos also hypothesized that mixed dominant children of high intelligence (I.Q. over 125) would be less likely to have reading difficulties than mixed dominant children of average intelligence, since the high I.Q. children would be able to use other cues to identify symbols. Her data supported this hypothesis since a significant positive relationship was found between reading disability and mixed dominance for children with I.Q.'s less than 125, but not for children of very superior intelligence. Koos found that I.Q. and mixed dominance were independent.

Finally Koos investigated the relationship between reversal in orientation on the W.I.S.C. Block Design and Picture Completion and reading achievement. Poorer readers tended to make more reversals.

The majority of Koos's hypotheses were supported but it is questionable whether the tenability of Orton's theory is supported, as she claims. A positive relationship between reversals on the W.I.S.C. performance tests is not a direct test of Orton's theory. Reversals are known to be a common error among poor readers and may be explained by confusion in directional orientation rather than by lack of

established dominance in the brain.

Coleman and Deutsch examined the relationship between lateral dominance and reading achievement in eighty-six nine to twelve year-old children who were taking part in a remedial reading program and thirty-five normals. They found no significant difference between normal and retarded readers in hand, eye or foot dominance, or in any combination of hand, eye or foot dominance. Coleman and Deutsch conclude that if existing tests of lateral preference measure cerebral dominance accurately then it does not appear to be causally related to reading disability. They concede it possible that these measures are open to experiential influences which obscure the underlying pattern of cerebral dominance, so that the relationship between hemispheric dominance and reading remains largely untested.

A study by Balow and Balow (1964) using 250 randomly chosen second grade children indicates no support at all for a relationship between lateral dominance and reading achievement. Analysis of covariance (with I.Q. as covariate) was used to compare children with established dominance and mixed dominance on word and paragraph reading scores. Also the age at which dominance became established was found to be unrelated to reading achievement. Balow and Balow conclude that "lateral dominance does not seem to be a fruitful area for seeking out determiners of individual differences in reading achievement" (p. 143).

Cohen and Glass (1968) carried out a study of sixty grade one and sixty grade four subjects who were either poor or good readers (according to teachers' ratings). The study offers no evidence to support a relationship between lateral preference and reading achievement. However, the study is notably deficient in its lack of

specification of tests and procedures used and in poor reporting of results.

Belmont and Birch (1965), aware of the shortcomings in previous research into the relationship between laterality and reading, attempted to design a study which would remedy these deficiencies. The sample came from the total school population from a single birth year in Aberdeen, Scotland. All the children were between nine years and four months and ten years and four months. Retarded readers were defined as those who scored at or below the tenth percentile on four reading tests. One hundred and fifty such children were randomly selected from the records along with 150 children not below the tenth percentile on the reading tests. Individual I.Q. data (W.I.S.C.'s) were available for each child. The findings indicated a somewhat larger percentage of retarded readers without established eyedness but the difference did not reach significance. Among retarded readers those with established hand and eye dominance had slightly higher reading scores than those with crossed dominance but again the differences were not significantly different from chance. In general the study found no consistent relationship between lateral preference and reading achievement.

Forness (1968) attempted to discriminate between retarded readers with neurological dysfunction and retarded readers without such dysfunction. The literature suggests that brain damaged slow readers would show more anomalous dominance than other retarded readers. No evidence to support this view was found. Anomalies of dominance shown by retarded readers were independent of brain dysfunction as measured by a neurologist's rating.

Trieschmann (1966) determined the handedness of second and

third grade normal and retarded readers by giving them a motor task involving the placement of pegs in holes and comparing the time taken to complete the tasks with each hand. She found that the handedness characteristics of the normal and retarded readers were the same. Subjects with incomplete handedness had no greater tendency to be retarded readers.

Lateral Dominance and Left-Right Discrimination

There does not appear to be much research dealing with the relationship between laterality and the ability to discriminate right from left despite the fact that clinical cases seem to present a more frequent occurrence of confusion between right and left in children with anomalies of dominance (Kinsbourne and Warrington, in Money, 1966, p. 66).

Benton and Meneffee (1957) studied the relationship between handedness and left-right discrimination in a sample of sixty-six kindergarten and grade school children. Handedness was determined by a thirty-five item battery which included a variety of tasks such as writing, cutting, folding and pointing. A significant correlation between left-right discrimination score on the Benton Test of Right-Left Discrimination and Handedness Deviation score (the amount the subject deviated from equal use of both hands) was found. Subjects with unilateral hand preference tended to be more proficient in left-right discrimination.

Belmont and Birch (1963) in a study of 148 children varying in age from five years and three months to twelve years and five months measured left-right discrimination with the Piaget tests and laterality

with Harris tests. They found no significant relation between the level of performance on left-right awareness and any type of lateral preference--either crossed, incomplete or established. An interesting finding was that the development of reliable left-right discrimination antedates the development of reliable hand preference by several years.

Summary

In general, then, the literature is supportive of a relationship between left-right discrimination and reading ability. Of the seven studies cited only one did not indicate a positive relationship. However, it appears that further study of the relationship between left-right awareness in grade one children with a sample of normal readers could profitably be carried out.

Research in the area of lateral dominance is generally less supportive of a relationship with reading. The bulk of the research cited showed insignificant relationships between reading achievement and various types of lateral dominance, though a few were positive and one indicated that established dominance was more commonly associated with reading errors. Unfortunately few of the studies are directly comparable since a wide variety of tasks was used by different authors to measure laterality, many of which are imprecise. Findings also vary depending on whether a clinic, school or other population is used, and whether extraneous sources of variance such as socioeconomic status are controlled. There has been very little research relating other indicators of cerebral dominance such as performance on the extensibility test, to reading.

Finally the two studies located which relate left-right

discrimination to lateral dominance contradict each other. One showed no relationship between the two variables and the other found less confusion in left-right discrimination among subjects with unilateral hand performance. No positive results were found which showed a relationship between crossed dominance and reading achievement.

CHAPTER III

DESIGN OF THE STUDY

The purpose of this chapter is to describe the sample, instruments, procedure and statistical analysis of data used in this study.

The Sample

The subjects for this study were sixty grade one children. The sample was selected from three grade one classes in three different schools made available to the writer by the Edmonton Public School Board officials in May, 1970. A request was made that three schools representative of the different socioeconomic areas of the city be allocated to the writer. The three schools chosen were from a high socioeconomic area, a medium socioeconomic area and a low socioeconomic area to minimize sampling bias.

In each school the principal made available one grade one class, from which twenty children were selected by the teacher on a random basis. Children who were repeating grade one or who had an I.Q. of less than eighty on the Detroit Beginners or the Lorge Thorndike were excluded from the sample. The final sample consisted of thirty boys and thirty girls with a mean age of 83.68 (6 years 11.68 months) months and a standard deviation of 4.93 months. Age was computed from the birthdates of the children as shown by the school records.

Instruments

The Neale Analysis of Reading Ability (Form A, 1966) was chosen

as the measure of reading achievement chiefly because it is a short, easily administered and well-standardized test of reading. Also the test gives information regarding the child's accuracy of reading, his comprehension of the material read orally, and a classification of the type of errors made. The test also gives a speed score but it was felt that for the purposes of this study this should be omitted. A total score combining comprehension, accuracy and speed is normally used in this test but for the present study the accuracy score only was used. The comprehension questions were used to ensure that the material the child had read was understood by him but were not included in the final scores. No subjects were omitted because they could not understand the reading passages. The speed score was omitted because the writer feels that speed is not an essential attribute of good reading at the grade one level. On the basis of the type of errors made on the Neale those subjects who made reversal errors were noted.

The test consists of six passages of graded difficulty and increasing length, with controlled variation of vocabulary and sentences. The test is untimed. Reliabilities for Accuracy scores on alternate forms are all above .96. Validity has been assessed by correlating the total scores with the Ballard test (.95) and the Schoneill (.95) (Buros, 1968, p. 372).

The Harris Tests of Lateral Dominance (See Appendix A) were administered to determine the handedness, eyedness or footedness of each subject so that lateral dominance status could be determined. This test seems to be the only published test which measures lateral dominance. It was favourably reviewed in the fourth Mental Measurements Yearbook (p. 644).

The test contains ten tasks to determine handedness. The child is asked to:

1. Throw a ball.
2. Wind a watch.
3. Brush teeth.
4. Comb hair.
5. Turn door knob.
6. Hold an eraser
7. Use scissors.
8. Hammer a nail.
9. Cut with a knife.
10. Write name with both hands (timed by a stopwatch).

A subject was classified as right-handed if he used his right hand for eight or more out of the ten tasks; left-handed if he used his left hand for eight or more out of the ten tasks; incomplete handed if he used the same hand less than eight times.

Two tasks from the Harris were given to determine the eyedness of the subjects. These tasks were to look through a telescope and to look through a hole in a card. A subject was classified as right-eyed if he used his right eye on both tasks, left-eyed if he used his left eye on both tasks, and incomplete if he used a different eye for each task.

Kicking and stamping were the tasks administered to determine footedness. The subject was judged to be right-footed if he used his right foot for both tasks, left-footed if he used his left foot for both tasks, and incomplete if he used a different foot for each task.

From the data on handedness, eyedness and footedness each

subject was classified as either having Established Dominance or Crossed Dominance. A subject with Established Dominance showed the same preference for hand, eye and foot while a subject with Crossed Dominance had a different hand preference to his eye and foot preference, i.e. the dominant hand was on the opposite side to the dominant eye or foot.

Harris reports a Spearman-Brown coefficient of reliability of .85 for handedness tasks. A contingency coefficient method of determining the reliability of the eye dominance data was used giving a reliability of .83. Reliability data were not available for the foot dominance tests. Harris claims face validity for the tests.

The Extensibility test was administered to each subject. The test was included as an additional measure of cerebral dominance. Hecaen and De Ajuriaguerra (p. 21) regard it as a more accurate measure of cerebral dominance than handedness. The test simply consists of asking the subject to extend his arms with his eyes closed and his fingers spread out. One hand is usually held slightly higher than the other. On the basis of this test and the handedness data from the Harris each subject was classified as either Consistent or Inconsistent. A consistent subject was one whose dominant hand on the Harris was the same as his elevated hand on the Extensibility test. An Inconsistent subject was one whose dominant hand was not the same as his elevated hand.

The Benton Test of Right-Left Discrimination (See Appendix B) was used to measure the extent to which subjects had attained the ability to discriminate between left and right. The test consists of thirty-two items altogether. Section A is a series of commands indicating that the

child should identify his own lateral body parts (twelve with eyes closed and twelve with eyes open). Section B contains four items which require the subject to identify lateral body parts on a picture of a man. Section C consists of four items which involve identification of lateral body parts of both the child and the picture (e.g. "Put your right hand on the man's left ear.")

Each subject was given a separate score on sections A, B, and C of the Benton as well as a composite total of the three scores. Subjects were also classified on the following basis.

1. On section A of the Benton subjects having scores of between twenty-two to twenty-four were classified as Discriminating on A, subjects having scores of between zero to two were classified as Consistently Reversing on A, subjects having scores of between two to twenty-two were classified as Confused on A.

2. On section B of the Benton subjects scoring any errors were classified as Confused on B while subjects scoring no errors were classified as Discriminating on B.

3. On section C of the Benton subjects scoring any errors were classified as Confused on C while subjects scoring no errors were classified as Discriminating on C.

Swanson and Benton (1955) report a Spearman-Brown split-half reliability of .88 and coefficients of equivalence of .72 and .67.

The Wechsler Intelligence Scale for Children vocabulary sub-test was included in the study as a measure of verbal ability. It is not intended as an all-encompassing measure of language but as a simple, quick and accurate estimate of the child's verbal status. The sub-test consists of a series of words increasing in difficulty which the child is required

to define. It is reliable ($r = .77$, p. 13 manual) and its validity as a measure of verbal ability has been demonstrated by factor analytical studies which show that it loads highly on a verbal factor (Maxwell, 1959) and by its relatively high positive correlation of .66 with total verbal score (see manual p. 10).

The Frostig Developmental Test of Visual Perception was chosen as a measure of perceptual ability. The test is a well standardized measure of perception and consists of five sub-tests, each of which gauges a different aspect of perception. For the purposes of this study, the fourth and fifth sub-tests which measure spatial perception were thought to be of particular relevance to the nature of left-right discrimination.

The five sub-tests are:

1. Eye-Motor Coordination: This is a test of eye-hand coordination involving the drawing of continuous, straight, curved or angled lines between boundaries of various width from point to point, without guide lines.

2. Figure-Ground: This test involves shifts in perception of figures against increasingly complex backgrounds. Intersecting and hidden geometric forms are used.

3. Constancy of Shape: This test requires the recognition of certain geometric figures presented in a variety of sizes, shadings, textures, positions in space, and their discrimination from similar geometric figures.

4. Position in Space: Reversals and rotations of figures presented in series, must be discriminated in this test.

5. Spatial Relationships: The test involves the analysis of

simple forms and patterns which consist of lines of various lengths and at various angles, which must be copied by the child.

The Frostig has a test-retest reliability of .80. Validity has been investigated through correlation between scaled scores and teacher's ratings of classroom adjustment (.44), motor coordination (.50) and intellectual functioning (.50).

The Non-Verbal Test of Directional Orientation (hereafter referred to as the Non-Verbal Test) is an experimental test made up by the writer as an additional measure of left-right awareness. One criticism of the Benton is that it relies heavily on whether the child has knowledge of the verbal labels "left" and "right". It is possible that the child could have directional discrimination but do poorly on the Benton because the appropriate labels are not available. For this reason an attempt was made to construct a test of directional awareness which did not employ the words "left" and "right". The test consisted of three parts:

Subtest A consists of ten picture cards. A line was drawn down the middle of each card and the child was asked ten questions. The questions involve the subject raising the hand which is on the same side as an object in the picture, e.g. "raise your hand which is on the same side of the line as the dog." (See Appendix C).

Subtest C requires the subject to reproduce twelve nonsense words using magnetic letters on a metal tray. The experimenter first constructed the nonsense word; then, leaving the constructed word in front of the subject, asked him to make a similar word. The following verbal instructions were given: "Watch me carefully and when I have finished make this word exactly as I have done." The nonsense words were: puq, bap, peb, qub, bordis, daput, debum, qudos, qupez, breqof, drugas, padorz.

Subtest B involves the subject in touching the body parts of a picture of a man. The subject sits opposite the experimenter. Both subject and experimenter have in front of them and facing them an identical picture of a man. The following instructions were given: "Use the same hand as I am using and touch this leg (or other body part) of the man." There were eight tasks of this nature (See Appendix C).

Subtest A was based on clinical observation of children at the University of Alberta reading clinic. It was noticed that during testing children's eye acuity on the telebinocular equipment some children tended to raise their right hand to indicate an object to their left or vice versa, thus indicating a tendency to confuse the left and right orientation of the objects on the card at which they were looking.

Subtest B is based on a study by Koos (1964) in which a relationship was found between reading achievement and the ability to construct sequential stories (Picture Completion) and to copy designs (Block Design) on the Wechsler Intelligence Scale for Children. The test differed from the W.I.S.C. subtests used by Koos in that nonsense words were employed. Nonsense words were used to avoid differences in individuals due to past learning of words. Letters rather than designs were used because the task seems more relevant to reading. The nonsense words were made up from the letters Money (1966, p. 24) considers most prone to directional confusion. The words follow the pattern of English words and are a mixture of one and two syllables.

Subtest C was based on subtest C of the Benton with the labels "left" and "right" omitted. The present test is, however, longer (eight items) and more complex than the Benton C. The subject is required to reverse both the tester's movement and the image in front

of him.

Subjects scoring twenty-two (the median) and over were classified as Discriminating while those who scored less than twenty-two were classified as Confused.

Collection of Data

The data for this study were collected during the first three weeks of May, 1970. All the testing was carried out by the writer in the schools. Individual testing was done in a quiet room and group testing was done in the classroom. Each subject was given the Neale Analysis of Reading Ability (Form A), the Harris Test of Lateral Dominance, the Extensibility test, the Benton Test of Right-Left Discrimination, and the W.I.S.C. Vocabulary Subtest individually. The Frostig Developmental Test of Visual Perception was administered to groups of twenty. The individual testing took approximately forty minutes and the group testing took about twenty minutes. The individual tests were administered in random order for each subject. Scoring for all tests was done by the experimenter according to the criteria laid down by the originators of the tests. In all cases raw scores rather than standards scores were used in the analysis since age was included as a variable. Separate subtest scores were analyzed as well as total scores for the Benton, the Frostig and the N.V.D.O.

Statistical Analysis of Data

1. Pearson product-moment correlations between age; Neale Analysis of Reading Ability score; W.I.S.C. vocabulary score; Benton subtest and Total scores; Non-Verbal subtest and total scores; Frostig

subtest and Total scores, and probability values for each r were computed (APL360 DEST02).

2. T-tests for independent groups were used when comparisons of the means of two groups was required. Where the equal variance assumption was violated Welch's approximation of T was calculated. (APL360 program ANOV10).

A. The Neale scores of the following pairs of groups were compared:

- a) Confused and Discriminating subject on the Benton B.
- b) Confused and Discriminating subjects on the Benton C.
- c) Confused and Discriminating subjects on the Non-Verbal Test.
- d) Crossed and Established Dominant subjects.
- e) Consistent and Inconsistent subjects on the Extension test.

B. The Frostig and W.I.S.C. scores of the following pairs of groups were compared:

- a) Confused and Discriminating subjects on the Benton B.
- b) Confused and Discriminating subjects on the Benton C.
- c) Confused and Discriminating subjects on the Non-Verbal Test.
- d) Crossed and Established dominant subjects.
- e) Consistent and Inconsistent subjects on the Extension test.

C. The Benton and Non-Verbal test scores of the following pairs of groups were compared.

- a) Subjects who made Reversal errors on the Neale and those

who did not.

b) Crossed and Established Dominant subjects.

c) Consistent and Inconsistent subjects on the Extension test.

3. When comparison of three groups was required a one-way analysis of variance was carried out. If F's were significant a Newman-Keuls test was performed on the means to determine between which means the differences lay. The following analysis of variance were computed using APL360 program ANOV15.

A. With status on the Benton A (either Confused, Discriminating or Consistently Reversing) as the independent variable, analyses of variance were carried out with Neale, Benton, Frostig and W.I.S.C. vocabulary scores as dependent variables.

B. With status on the Harris (either Left, Right or Incomplete Handed) as the independent variable, analyses of variance were carried out with Neale, Benton, Frostig, and W.I.S.C. vocabulary as the dependent variables.

C. As in B analyses were carried out with Left, Right and Incomplete Eyedness as the independent variable and also with Left, Right and Incomplete footedness as the independent variable.

4. A one-way analysis of covariance with status on the Benton A as the independent variable, Neale reading score as the criterion and W.I.S.C. vocabulary score as the covariate, was computed to determine whether left-right discrimination affects reading when verbal ability is partialled out.

5. A chi-square frequency test was carried out to test whether Crossed or Established dominant subjects were more likely to be

categorized as making reversal errors on the Neale or not.

6. Chi-square frequency tests were substituted for analyses of variance whenever there was zero variance on a test. This happened with the Non-Verbal test.

Summary

This chapter has described the sample, the instruments, the procedure and the statistical analysis used in this study. Sixty grade one children were tested individually on:

1. The Neale Analysis of Reading Ability.
2. The Harris Tests of Lateral Dominance.
3. The Extensibility test.
4. The Benton Test of Right-Left Discrimination.
5. The Non-Verbal Test of Directional Orientation.
6. The W.I.S.C. vocabulary subtest.

The children were also tested in groups on the Marianne Frostig Developmental Test of Visual Perception. Correlations between variables were computed and T-Tests, chi-square tests and a number of analyses of variance were also carried out on the data.

CHAPTER IV

RESULTS

This chapter presents the results of the study and a discussion of the results under the following headings:

1. Performance on tests of Left Right Discrimination.
2. Performance on Reading, Verbal and Visual-Perceptual Tests.
3. Performance on tests of Lateral Dominance.
4. Relationship between verbal and non-verbal Left-Right Awareness.
5. Relationship between Left-Right Discrimination and Reading.
6. Relationship between Left-Right Discrimination and Verbal Ability.
7. Relationship between Left-Right Discrimination and Visual Perceptual Ability.
8. Relationship between Lateral Dominance and Reading Ability.
9. Relationship between Lateral Dominance and Left-Right Discrimination.
10. Relationship between Lateral Dominance and Verbal Ability.
11. Relationship between Lateral Dominance and Visual-Perceptual Ability.

Performance on Tests of Left-Right Discrimination

The Benton Test of Right-Left Discrimination

Table I indicates the means and standard deviations of subjects' scores on the Benton and Non-Verbal test, while table II presents the

percentage of subjects who are Discriminating and Confused on these tests. The mean of 17.33 (out of a possible 24) on the Benton A indicates that most children were able to correctly point to their own left and right body parts. However, it must be remembered that a child may get half of the items correct by guessing. Using Benton's criterion for having achieved discrimination (a score of over 22) Table II illustrates that half of the subjects were Discriminating on the Benton A, while one tenth of the sample were Consistently Reversing, i.e. they could discriminate right from left but were unable to give the right verbal label for the directions. It is most appropriate to include the Consistently Reversing subjects in the Discriminating group since they only lack the ability to label and not to discriminate. If this is done

TABLE I

MEANS AND STANDARD DEVIATIONS OF
LEFT-RIGHT DISCRIMINATION TESTS

	Benton				Non-Verbal Test			
	A	B	C	Total	A	B	C	Total
Means	17.33	1.63	1.04	20.01	9.83	2.38	11.75	23.89
Standard Deviations	8.15	1.73	1.12	8.53	0.58	2.69	0.95	3.06
Possible Scores	24	4	4	32	10	8	12	30

TABLE II

PERCENTAGE OF CONFUSED, DISCRIMINATING AND CONSISTENTLY
REVERSING SUBJECTS ON THE BENTON AND
NON-VERBAL TEST

	Benton A		Benton B		Benton C		Non-Verbal Test	
	N	%	N	%	N	%	N	%
Confused	23	38.4	43	71.6	58	96.7	31	51.6
Discrimin- ating	31	51.6	17	28.4	2	3.3	29	48.4
Consis- tently Reversing	6	10						

61 percent of the sample can be considered able to discriminate their own lateral body parts.

Subtests B and Subtests C of the Benton were progressively more difficult as can be seen by the low means on Table I and by the low percentage of discriminators on Table II, only about one quarter of the sample were Discriminating in identifying the lateral body parts of a man while only 3.3 percent of the sample were Discriminating in identifying their own and the man's lateral body parts.

A progressively smaller number of children were able to attain the higher levels of discrimination.

The present data is in agreement with Piaget who suggested that children achieve stage one left-right discrimination (which corresponds to the Benton A) between the ages of five and eight. The present sample has a mean age of six years and eleven months and roughly two-thirds of

them have achieved stage one discrimination. Piaget (1928) finds that stage two discrimination (Benton B) is not generally reached until eight to eleven years, while stage three discrimination (Benton C) comes at about eleven to twelve years. Hence a small number of stage two and three discriminators would be expected in the present sample in accordance with the findings.

Swanson and Benton (1955) say that very rapid development in left-right discrimination occurs between six and seven and also find that most children have achieved own body discrimination at seven years. The findings of this study are also in accord with those of Belmont and Birch (1963) although in that study not quite such universal acquisition of stage one discrimination was achieved. Belmont and Birch found that awareness of own body parts was stabilized by the age of seven. However, the present study is not directly comparable to that of Belmont and Birch since they used a different measure of left-right awareness, namely, the Piaget tests.

Non-Verbal Test of Directional Orientation

The means of subtest A (9.83 out of 10) and subtest C (11.7 out of 12) on the Non-Verbal test show that these subtests were successfully completed by the vast majority of the subjects. The standard deviations of .58 for subtest A and .95 for subtest C indicate the very uniform performance of the group on these subtests.

The ability to indicate the position of objects in a picture by raising the hand on the same side as the objects was present in almost all the children tested, which suggests that this task is a good deal easier than the discrimination of own lateral body parts which one third

of the sample could not achieve. Similarly, the children in this sample had no difficulty in copying a nonsense syllable which contained letters susceptible to reversal errors. The ease with which the children completed the letter task is interesting when it is considered how common reversal errors are in children of this age. It may be that the large bold plastic letters which were used for the task helped to engage the children's attention. The tactile properties of the letters may have also made discrimination easier.

The mean of Subtest B on the Non-Verbal test, 2.38 out of 8, suggests that this task was a great deal more difficult. A very small proportion of the subjects were able to successfully copy the movements of the experimenter as he placed his left or right hand on the lateral body parts of a picture of a man. The subjects typically made mirroring or object-mirroring responses on this test. The results are not surprising in view of the fact that the task presented is very similar to the Benton C except that labels are not given. Only 3.3 percent of the sample were successful on the Benton C. The test appears to be measuring Piaget's stage three left-right awareness which he found was not acquired till the age of eleven to twelve. Moreover in similar double transposition tasks Wapner and Cirillo (1968) found that some subjects did not acquire this ability till as late as twelve to fourteen years.

Performance on Reading, Verbal and Visual-Perceptual Tests:

The Neale Analysis of Reading Ability

Table III shows that the mean accuracy score of the sample on the Neale was 18.05. The reading age equivalent for this raw score is 7.4

TABLE III

MEANS AND STANDARD DEVIATIONS OF READING,
PERCEPTUAL AND VERBAL SCORES

Neale		W.I.S.C. Vocab.	Frostig					
			I	II	III	IV	V	TOTAL
Means	18.05	17.43	21.28	12.61	8.18	6.46	6.21	54.73
Standard Deviations	8.17	5.13	4.11	3.14	3.68	1.30	1.20	9.42

indicating that the mean reading age of the sample is about five months in advance of its chronological age. The standard deviation of 8.17 shows that about two thirds of the sample scored between ten (reading age of six years and ten months) and 26 (reading age of seven years and eleven months).

Subjects who made reversal errors on the Neale were noted while testing was carried out. Twelve subjects out of the sixty in the sample made reversal errors. No subject made more than one reversal error and every subject who made a reversal error made the error on the same word.

The W.I.S.C. Vocabulary Subtest

The sample mean of 17.43 out of a possible eighty (see Table III) for the W.I.S.C. vocabulary is equivalent to a scaled score of nine. It is somewhat difficult to interpret a single subtest scaled score equivalent since no basis for comparison is provided in the manual for individual subtests. However, the score of this sample is in the average

range for this particular age level. The standard deviation of 5.13 indicates that about two thirds of the sample scored between twelve and twenty-three.

The Frostig Developmental Test of Visual Perception

The scoring manual of the Frostig (p. 38) allows a calculation of the mean Perceptual Quotient of the children in the present sample. The mean Perceptual Quotient corresponding to the scores in Table III is 105, indicating that the present sample is slightly superior in perceptual ability to the standardization sample. A Perceptual Quotient of 105 falls at just about the sixtieth percentile (see p. 32 scoring manual) showing that the present sample scored above sixty percent of the standardization sample.

Performance on Lateral Dominance Tests

Handedness, Eyedness and Footedness

Table IV indicates the number of individuals who were left, right or incomplete handed, eyed or footed. The percentage of left-handers, 11.6, is a fairly typical figure although tending towards the high end of the scale. Hecaen and De Ajuriaguerra (1964) in reviewing forty-eight different studies of handedness found that incidence of left-handedness varied in these studies from one to twenty-five percent, although the majority of the studies show figures between five and twelve percent. There was a small percentage, 5.1 percent, of individuals with mixed handedness in this study. Belmont and Birch (1963) report 28 percent of mixed handedness and Harris reports 32 percent, in similarly aged samples.

The percentage of incomplete handedness found in this study is more comparable with that found in the nine year old sample of Belmont and Birch. They claim that hand preference does not become consistent until about age ten on the basis of findings of a large number of mixed handers before this age. However, if amount of mixed handedness is an indicator of developmental inconsistencies, the present sample with a mean age of only six years and eleven months seems to have largely reached the stage of preferentially using one hand.

Footedness figures in this study are remarkably similar to figures cited by Harris (1957) and Belmont and Birch (1963). The figures of 13.3 percent left-footed individuals and 5.0 percent incomplete-footedness are rather similar to the figures of handedness although there are slightly more left-footed individuals than left-handed. The latter may be due to the greater susceptibility to social pressure of handedness. The low percentage of mixed footedness indicates again that the preferential use of one foot was largely achieved in this sample.

The highest proportion of left laterality is found in eyedness where 31.7 percent of the subjects were left-eyed. This figure is slightly lower than that of Harris (39 percent) and somewhat higher than that of Belmont and Birch (20 percent). The high proportion of left-eyedness may be indicative of its relative immunity to environmental influence but also there is a good deal of doubt that eyedness is a unilateral function at all since both hemispheres receive fibres from the optic nerve. The present sample has a very small proportion (3.3 percent) of mixed eyedness in comparison to other studies (Belmont and Birch - 28 percent; Harris - 8.5 percent). There is more reason to doubt the

TABLE IV

PERCENTAGE OF ESTABLISHED AND
INCOMPLETE LATERALITY

	Handedness		Footedness		Eyedness	
	N	%	N	%	N	%
Left	7	11.6	8	13.3	19	31.7
Right	50	83.3	49	81.7	39	65.0
Incomplete	3	5.1	3	5.0	2	3.3
Total	60	100				

reliability of measurement of eyedness and footedness since a small number of tasks are used to measure them in comparison to handedness. This may account for some of the variability in figures among different studies.

Crossed and Established Laterality (See Table V)

The findings of this study that approximately two thirds of the sample showed the consistent use of one side of the body (established laterality) are in agreement with most figures found in the literature (Harris, 1957; Sptizer, Rabkin and Kramer, 1959; Coleman and Deutsch, 1964; Belmont and Birch, 1963). Other studies report percentages of crossed dominance varying from 27 percent to 36 percent - the figure tends to be smaller for older samples. The percentage of 36.7 percent crossed dominance in this study is typical of findings in similar age groups.

TABLE V

CROSSED AND ESTABLISHED LATERALITY AND
EXTENSIBILITY DATA

	Laterality		Extensibility			Extensibility		
	N	%		N	%	N	N	%
Crossed	23	36.7	Left	22	36.7	Consistent	42	70.0
Established	37	63.3	Right	38	63.3	Inconsistent	18	30.0

Extensibility

This test showed that 36.7 percent of the sample elevated their left hand which supposedly indicated that they were right cerebral dominant, and 63.3 percent elevated their right hand, that is they were left cerebral dominant. There is a discrepancy between indications of cerebral dominance from handedness and from the Extensibility test. The latter showed a larger proportion of right cerebral dominant individuals. This finding may be due to the greater influence of environmental pressure on handedness. It is difficult to compare the present findings with those of other studies since the test has neither been widely used nor carefully reported. For example Silver and Hagin (1960) report the figures only for their reading disabled group in which they found that 74 percent of the children elevated a different hand from the dominant one. This group has been called Inconsistent in the present investigation and comprised 30 percent of the total sample.

Relationship Between the Benton and the Non-Verbal Test

The Non-Verbal test was included in this study in addition to the Benton to try to assess left-right discrimination without the Benton's reliance on verbal labelling ability. Nonetheless it was expected that there would be a good deal of overlap between the two tests since both set out to measure different aspects of the same ability. Table VI contains the intercorrelations between the subtest and Total scores of the Benton and the Non-Verbal test.

TABLE VI

INTERCORRELATIONS BETWEEN NON-VERBAL TEST
AND BENTON

N=60	1	2	3	4	5	6	7	8
1. Benton A	1.00	-0.11	0.17	0.94**	0.27*	0.03	0.25*	0.14
2. Benton B		1.00	0.44**	0.16	0.09	0.14	0.07	0.17
3. Benton C			1.00	0.38**	-0.14	0.10	0.07	0.09
4. Benton Tot.				1.00	0.25*	0.07	0.26*	0.18
5. Non- Verbal A					1.00	0.06	0.58**	0.42**
6. Non- Verbal B						1.00	0.04	0.87**
7. Non- Verbal C							1.00	0.44**
8. Non-Ver Verbal Tot.								1.00

* Significant at the 0.05 level

** Significant at the 0.01 level

There are significant correlations at the 0.05 level between the Benton A and the Non-Verbal A and Non-Verbal C (.27 and .25), and between the Benton Total and Non-Verbal A and Non-Verbal C at the 0.01 level (.42 and .44). Since the variability in the Benton total appears to be largely due to the Benton A, it is not surprising that the correlations which occur between the Non-Verbal A and C and the Benton A are repeated with the Benton Total. These correlations seem to indicate that the abilities tapped in the Non-Verbal A (indicating the directions of objects in a picture about a midline) and the Non-Verbal C (copying nonsense syllables) have a lot in common with what the Benton A measures, namely the ability to identify one's own body parts or stage one left-right awareness. Despite the fact that the Non-Verbal A and C were somewhat easier and more widely acquired by the grade one sample than the Benton A it appears that these tests are all measuring the same basic directional orientation ability.

Although it might be expected that the difficult Non-Verbal B would correlate with more advanced levels of left-right awareness, especially stage three (as measured by the Benton C), correlations between these two subtests although in the expected direction do not reach significance.

Since the variability in the Total scores of the Non-Verbal test is largely due to the Non-Verbal B, and the variability in the Benton total is largely due to the Benton A, it is not surprising that there is no significant correlation between the two totals although the correlation is in the expected direction (.18).

Relationship Between Left-Right Discrimination and Reading:

Table VIIa shows that there is a significant difference at beyond the .01 level between the Neale scores of Discriminating and Confused and Consistently Reversing Subjects on the Benton A. The Newman-Keuls indicates that the Discriminating group on the Benton A did better on the Neale than the Confused group. The Consistently Reversing group did not have a significantly lower mean on the Neale than the discriminating groups nor a significantly higher mean than the Confused group, but the mean of the Consistently Reversing group falls in between that of the Discriminating and Confused groups, somewhat closer to the Discriminating group.

TABLE VIIa

COMPARISON OF DISCRIMINATING, CONFUSED AND CONSISTENTLY
REVERSING GROUPS ON THE BENTON A

<u>Summary of Analysis of Variance on Neale Scores:</u>					
Source of Variance	SS	df	MS	F	P
Between Groups	687.0	2	344	5.88	0.005**
Within Groups	333.2	57	58.5		
<u>Newman-Keuls Tests on Means:</u>					
Means	1	2	3		
	20.83	18.83	13.65		
3	7.19*	5.18			
2	2.01				
1					
Group 1 - Discriminating * Significant at the .05 level Group 2 - Consistently Reversing **Significant at the .01 level Group 3 - Confused					

An analysis of covariance, (Table VIIb) with W.I.S.C. scores as the covariate and Neale scores as the criterion, on the Discriminating, Confused and Consistently Reversing groups on the Benton A, shows that even when verbal ability is partialled out, a significant effect of stage one left-right discrimination on reading achievement exists.

TABLE VIIb

SUMMARY OF ANALYSIS OF COVARIANCE ON ADJUSTED MEANS

Source of Variance	df	MS	Adj.F	P
Between Groups	2	200.73	3.72	0.03*
Within Groups	56	53.91		
Adjusted Means: Group 1 - 20.55; Group 2 - 16.69; Group 3 - 15.01				

The above results indicate that the ability to discriminate own lateral body parts has a significant effect on reading achievement at grade one. However, the inability to label correctly left and right does not appear to have an adverse effect on reading scores. Table VIII which shows a significant positive correlation (.27) between Neale scores and Benton A scores supports the conclusions made on the basis of the analysis of variance data, namely that higher achievement in reading is associated with more accurate discrimination of left and right.

Table IX shows that there is no significant difference between the Neale scores of subjects who discriminate and subjects who are confused on the Benton B or the Benton C. The correlation data in Table VIII indicate a negative correlation between Benton B and the Neale,

TABLE VIII
CORRELATIONS BETWEEN THE NEALE AND TESTS
OF LEFT-RIGHT DISCRIMINATION

	A	<u>Benton</u>		Total	<u>Non-Verbal Test</u>			
		B	C		A	B	C	Total
Neale	0.27*	-0.22	-0.28*	0.18	0.26*	0.002	0.20	0.12

and Benton C and the Neale. There does not seem to be an apparent theoretical explanation of this and it seems likely that a spurious results may have been given because the Benton B and the Benton C are not normally distributed, while a normal distribution is a necessary condition for a meaningful linear correlation.

TABLE IX
T-TESTS COMPARING CONFUSED AND DISCRIMINATING GROUPS
IN THEIR NEALE SCORES

	N	MEANS	S.D.	T	P
<u>Benton B</u>					
Discriminating	17	16.12	7.75	-1.04	0.30
Confused	43	18.38	8.25		
<u>Benton C</u>					
Discriminating	2	17.00	10.00	0.15	0.87
Confused	58	17.91	8.11		
<u>Non-Verbal Test</u>					
Discriminating	31	17.35	9.38	0.51	0.61
Confused	29	18.45	6.63		

It appears that the ability to discriminate between right and left at the stage two and three levels is not related to the ability to learn to read. This is not surprising in view of the fact that these abilities are not acquired until well after the age when reading is normally achieved.

The Non-Verbal A shows a significant positive correlation with the Neale scores (.26) and the Non-Verbal C - Neale correlation almost reaches significance (.20) (See Table VIII). However, the Non-Verbal B does not appear to be related to Neale reading achievement. T-tests (see Table IX) do not reveal a significant difference between Discriminating and Confused subjects on the Non-Verbal test. These data seem to indicate, as with the Benton, that it is basic skill in directional orientation from the individual's own framework (stage one left-right awareness) which is important for beginning readers.

Table X gives figures which compare subjects who made reversal errors on the Neale and those who did not make such errors in their Benton and Non-Verbal scores. The only significant differences which appeared between the two groups were on the Benton A and the Benton B. Subjects who made reversal errors scored lower on the Benton A but higher on the Benton B. The finding that subjects who made errors of reversal in reading were poorer in discriminating right and left on their own bodies is what would be expected and is further evidence to support a relationship between directional orientation and reading. However, the finding that Benton B scores were higher for subjects who made reversal errors in reading is hard to explain. Possibly it may be a statistical artifact brought about by violation of t-test assumptions particularly lack of normality in the distribution of Benton B scores.

TABLE X

T-TESTS COMPARING SUBJECTS WHO MADE REVERSAL ERRORS WITH THOSE WHO
DID NOT ON BENTON AND NON-VERBAL

	N	MEANS	S.D.	T	P
<u>Benton A Scores:</u>					
Reversers	12	13.00	6.10	2.50	0.015*
Non-Reversers	48	19.31	6.99		
<u>Benton B Scores:</u>					
Reversers	12	2.83	1.57	2.83	0.006**
Non-Reversers	48	1.33	1.62		
<u>Benton C Scores:</u>					
Reversers	12	1.33	1.03	0.974	0.333
Non-Reversers	48	0.98	1.13		
<u>Benton Total Scores:</u>					
Reversers	12	20.92	9.28	0.406	0.686
Non-Reversers	48	19.79	8.23		
<u>Non-Verbal A Scores:</u>					
Reversers	12	9.83	0.37	0.0	0.69
Non-Reversers	48	9.83	0.62		
<u>Non-Verbal B Scores:</u>					
Reversers	12	2.33	2.81	-0.07	0.94
Non-Reversers	48	2.40	2.64		
<u>Non-Verbal C Scores:</u>					
Reversers	12	11.83	0.37	0.38	0.74
Non-Reversers	48	11.73	1.04	(T = 0.57)	(0.57)
<u>Non-Verbal Total:</u>					
Reversers	12	24.00	2.89	0.125	0.90
Non-Reversers	48	23.88	3.08		

Relationship Between Left-Right Discrimination and Verbal Ability

Table XI indicates a significant difference at the .01 level between the W.I.S.C. vocabulary scores of Discriminating, Confused, and Consistently Reversing subjects on the Benton A. According to the Newman-Keuls test, the Consistently Reversing group did significantly better than the Confused group but no other differences between means were significant. The Consistently Reversing group had the highest mean and the confused group had the lowest mean, while the Discriminating group fell in between.

TABLE XI

COMPARISON OF DISCRIMINATING, CONFUSED AND CONSISTENTLY
REVERSING GROUPS ON THE BENTON A

Summary of Analysis of Variance on W.I.S.C. Vocabulary Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	202.68	2	101.34	4.28	0.01**
Within Groups	1350.04	57	23.69		

Newman-Keuls Test on Means:

	2	1	3
Means	21.67	18.03	15.52
3	6.14**	2.51	
1	3.63		
2			

The finding that the Consistently Reversing group has a better Vocabulary score than the Confused group is evidence that the ability to discriminate left and right at stage one is related to verbal ability, although it is surprising that the Discriminating group did not also do better than the Confused group. However, the labelling skills of naming the directions correctly does not appear to be an important facet of this verbal ability. It is more likely that the verbal factor in left-right awareness is important in the verbal mediation of solving the problem of differentiating positions in space.

There are no significant differences between the W.I.S.C. scores of Discriminating and Confused subjects on the Benton B and Benton C (See Table XIII), nor were the correlations between these tests significant (See Table XII). Hence this study does not bear out Benton's hypothesis that verbal ability is related to the more advanced stages two and three of left-right awareness.

TABLE XII

CORRELATIONS BETWEEN THE W.I.S.C. VOCABULARY AND
BENTON AND NON-VERBAL

	BENTON				NON-VERBAL			
	A	B	C	Total	A	B	C	Total
W.I.S.C. Vocabulary	-0.03	0.01	-0.23	-0.06	0.16	0.17	0.21	0.25*

TABLE XIII

T-TESTS COMPARING W.I.S.C. SCORES OF DISCRIMINATING AND
 CONFUSED GROUPS ON BENTON B, C,
 AND NON-VERBAL

	N	MEANS	S.D.	T	P
<u>Benton B</u>					
Discriminating	17	18.71	5.64	1.21	0.23
Confused	43	16.93	4.76		
<u>Benton C</u>					
Discriminating	2	17.00	0.0	0.12	0.90
Confused	58	17.45	5.17		
<u>Non-Verbal</u>					
Discriminating	29	17.66	5.06	0.32	0.75
Confused	31	17.23	5.10		

Although the Discriminating and Confused subjects on the Non-Verbal test did not differ in their W.I.S.C. scores (See Table XIII), the correlation between Non-Verbal total and W.I.S.C. vocabulary is significant at the .05 level. This finding is interesting in view of the fact that verbal labels were specifically excluded from the test. The relationship between performance on the Non-Verbal test and the W.I.S.C. vocabulary may be further evidence that left-right awareness involves verbal mediation of a more complex nature than simple labelling.

Relationship Between Left-Right Discrimination and Visual Perceptual Ability

Table XIV shows that the confused, Discriminating and Consistently Reversing groups on the Benton A differ significantly at the .01 level in their Frostig IV (Position in Space) scores. The Consistently Reversing

TABLE XIV

COMPARISON OF FROSTIG SCORES OF DISCRIMINATING, CONFUSED AND
CONSISTENTLY REVERSING SUBJECTS ON THE BENTON A

Summary of Analysis of Variance on Frostig I Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	51.36	2	25.68	1.54	0.22
Within Groups	948.82	57	16.65		

Summary of Analysis of Variance on Frostig II Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	18.05	2	9.03	0.91	0.41
Within Groups	564.12	57	9.90		

Summary of Analysis of Variance on Frostig III Scores:

Between Groups	49.53	2	24.77	1.88	0.16
Within Groups	751.44	57	13.18		

Summary of Analysis of Variance on Frostig IV Scores:

Between Groups	16.67	2	8.34	5.64	0.005**
Within Groups	84.26	57	1.48		

TABLE XIV
(Continued)

Newman-Keuls Test on Means:

	2	1	3	
Means	7.67	6.65	5.91	
3	1.75**	0.73		Group 1 - Discriminating
1	1.02			Group 2 - Consistently
2				Reversing
				Group 3 - Confused

Summary of Analysis of Variance on Frostig V Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	1.60	2	0.80	0.54	0.58
Within Groups	84.57	57	1.48		

Source of Variance	SS	df	MS	F	P
Between Groups	426.0	2	213	2.52	0.09
Within Groups	4811.75	57	84.4		

group obtained the highest score, the Confused group the lowest score while the Discriminating group fell in between. Only the differences between the Consistently Reversing and the Confused group were statistically significant, although the difference between the Discriminating and Confused group almost reached significance. Subjects who were able to discriminate their own lateral body parts without the correct label were thus superior in their ability to determine position in space. The fact that the Frostig IV is related to ability to discriminate is not surprising since the test

involves detecting objects which are rotated in space, a task which seems to depend on directional orientation. The results indicate that subjects without the ability to label "left" and "right" are not at a disadvantage in Visual Perceptual ability and are considerably superior in this ability to those who confused left and right.

Table XV indicates the significant superiority of the Discriminating subjects on the Benton B over the Confused subjects in their Frostig I and Frostig IV scores. Stage two left-right awareness then is related to the Visual-Perceptual Abilities of Eye-Motor Co-ordination as well as Position in Space. The relationship between eye-motor coordination and left-right discrimination is interesting since it may illuminate the link found in this study between lateralized body function and left-right discrimination.

Preferential motor use of one side of the body has been argued (Benton, 1959) to be a cause of greater awareness of left and right and the correlation between Eye Motor Co-ordination and left-right discrimination supports this argument.

The Benton C does not show any significant relationship to visual-perceptual ability in this study (see Table XV). However, it is hard to conclude that visual-perceptual ability is unrelated to stage three of left-right awareness since there were only two subjects in the Discriminating group and a larger number of subjects would be necessary to reveal a relationship.

The data of Table XVI indicate several significant correlations between the scores of the Non-Verbal test and the Frostig, although the t-tests in Table XV do not reveal this relationship. Non-Verbal totals are significantly related to Frostig II (Figure-Ground Discrimination) and

TABLE XV

T-TESTS COMPARING CONFUSED AND DISCRIMINATING GROUPS
ON BENTON AND NON-VERBAL

Comparison of Confused and Discriminating Groups on Benton B					
	N	MEANS	S.D.	T	P
Frostig I:					
Discriminating	17	22.94	2.39	2.01	0.01**
Confused	43	20.63	4.41	(T'=2.60)	(0.01)
Frostig II:					
Discriminating	17	13.00	3.45	0.59	0.56
Confused	43	12.47	2.96		
Frostig III:					
Discriminating	17	8.41	4.00	0.30	0.77
Confused	43	8.09	3.50		
Frostig IV:					
Discriminating	17	7.00	1.28	2.04	2.05*
Confused	43	6.26	1.24		
Frostig V:					
Discriminating	17	6.53	0.85	1.27	0.21
Confused	43	6.09	1.29	(T'=2.04)	(0.13)
Frostig Total:	17	57.88	8.22	1.65	0.10
Comparison of Confused and Discriminating Groups on Benton C					
	N	MEANS	S.D.	T	P
Frostig I:					
Discriminating	2	23.00	1.00	0.60	0.55
Confused	58	21.22	4.14		
Frostig II:					
Discriminating		14.50	4.50	0.86	0.39
Confused		12.55	3.04		

TABLE XV
(Continued)

	N	MEANS	S.D.	T	P
Frostig III:					
Discriminating		6.50	1.50	-0.65	0.52
Confused		8.24	3.69		
Frostig IV:					
Discriminating		5.00	2.00	-1.64	0.11
Confused		6.52	1.24		
Frostig V:					
Discriminating		6.50	0.50	0.34	0.74
Confused		6.21	1.21		
Frostig Total					
Discriminating		55.50	9.50	0.12	0.91
Confused		54.71	9.34		

Comparison of Confused and Discriminating Groups on Non-Verbal Test

	N	MEANS	S.D.	T	P
Frostig I:					
Discriminating	29	21.83	4.40	-0.990	0.32
Confused	31	20.77	3.69		
Frostig II:					
Discriminating		13.21	3.06	-1.420	0.16
Confused		12.06	3.07		
Frostig III:					
Discriminating		8.52	3.90	-0.68	0.50
Confused		7.87	3.38		
Frostig IV:					
Discriminating		6.55	1.35	-.45	0.63
Confused		6.39	1.24		

TABLE XV
(Continued)

	N	MEANS	S.D.	T	P
Frostig V:					
Discriminating		6.38	1.16	-1.01	0.32
Confused		6.06	1.22		
Frostig Total:					
Discriminating		53.48	9.56	-1.40	0.17
Confused		53.10	8.83		

to Frostig V (Spatial Relations), while Frostig IV correlates significantly with Non-Verbal A and Non-Verbal C and Non-Verbal C is positively related to Frostig V. No correlations with the Non-Verbal B, which is more related to the higher levels of left-right discrimination were found. It appears, therefore, that the aspects of Visual-Perceptual Ability (except Eye-Motor Coordination - Frostig III) measured by the Frostig are associated with the ability to discriminate right from left non-verbally, especially at the level of discrimination from the child's own point of view (stage one).

The Relationship between Lateral Dominance and Reading Ability

The data in Table XVII and Table XVIII give no support to a relationship between reading achievement and lateral dominance. Foot, hand or eye preference is not reflected in Neale scores, since no significant differences occur between subjects with Left, Right or Incomplete lateral preference in Neale performance.

Similarly, Table XVIII shows that Crossed and Established Dominant subjects do not differ in their Neale performance. Also Consistent

TABLE XVI

INTERCORRELATIONS BETWEEN THE BENTON AND NON-VERBAL
TEST AND FROSTIG

	BENTON				NON-VERBAL			
	A	B	C	Total	A	B	C	Total
Frostig I	0.04	0.24	0.14	0.11	0.14	0.05	0.14	0.15
Frostig II	0.19	0.01	0.19	0.21	0.16	0.21	0.14	0.29*
Frostig III	-0.04	0.03	-0.12	-0.05	0.11	0.09	0.05	0.14
Frostig IV	0.04	0.23	-0.15	0.06	0.34**	0.02	0.30**	0.18
Frostig V	0.09	0.07	0.004	0.10	0.21	0.16	0.27**	0.30**
Frostig Total	0.08	0.16	0.06	0.12	0.23	0.16	0.20	0.28**

TABLE XVII

THE EFFECT OF HANDEDNESS, FOOTEDNESS AND EYEDNESS
ON READING

Handedness:

Summary of Analysis of Variance on Neale Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	168.04	2	84.02	1.27	0.29
Within Groups	3772.8	57	66.19		

Footedness:

Summary of Analysis of Variance on Neale Scores:

Source of Variance	SS	df	MS	F	p
Between Groups	167.5	2	83.76	1.24	0.30
Within Groups	3852.7	57	67.59		

Eyedness:

Summary of Analysis of Variance on Neale Scores:

Source of Variance	SS	df	MS	F	p
Between Groups	26.5	2	13.25	0.19	0.82
Within Groups	3993.7	57	70.06		

and Inconsistent subjects performed equally well on the Neale.

These findings are in agreement with the majority of the studies in this area indicating a lack of relationship between lateral preference and reading achievement.

Chi-square tests (Table XIX) on contingency tables of the relationship between different types of lateral preference and reversal errors in reading revealed that Handedness, Footedness and Eyedness were independent of tendency to make reversal errors. However, a significant chi-square, at the .05 level, was computed from the contingency table of

TABLE XVIII
CROSSED AND ESTABLISHED DOMINANCE AND EXTENSIBILITY
AND READING

Crossed and Established Dominance and Reading:

	N	MEANS	S.D.	T	P
Neale:					
Crossed	23	17.18	8.68	-0.62	0.54
Established	37	18.55	7.71		

Consistent and Inconsistent on Extensibility and Reading:

	N	MEANS	S.D.	T	P
Neale:					
Consistent	42	17.90	7.14	0.03	0.97
Inconsistent	18	17.83	10.22		

TABLE XIX

CONTINGENCY TABLES SHOWING RELATIONSHIPS BETWEEN LATERALITY
REVERSALS IN READING

Crossed and Established Dominance:

df = 1	Crossed	Established	Total
Reversers	2 (4.2)	9 (6.8)	11
Non-Reversers	21 (15.5)	28 (30.2)	49
Total	23	37	60

Chi-Square = 4.05*

Handedness:

df = 2	Left	Right	Mixed	Total
Reversers	3 (1.4)	8 (10)	1 (.6)	12
Non-Reversers	4 (5.6)	42 (40)	2 (2.4)	48
Total	7	50	3	60

Chi-Square = 3.50

Footedness:

df = 2	Left	Right	Mixed	Total
Reversers	2 (1.4)	9 (8.2)	0 (.6)	11
Non-Reversers	6 (6.5)	40 (40)	3 (2.5)	49
Total	8	49	3	60

Chi-Square = 1.15

TABLE XIX
(Continued)

Eyedness:

df = 2	Left	Right	Mixed	Total
Reversers	3 (3.3)	7 (7.3)	1 (.4)	11
Non-Reversers	14 (14.7)	33 (33)	1 (1.6)	49
Total	18	40	2	60

Chi-Square = 1.197

crossed and established dominance and reversal errors indicating that the two variables were not independent. Inspection of the expected values for the cells indicates that there are fewer subjects who make reversal errors amongst crossed dominant subjects than there are amongst established dominant subjects. It is extremely difficult to explain this finding in theoretical terms. Orton's theory predicts the precise opposite, namely that crossed dominant subjects will make more reversal errors because of the mirroring effect from two competing hemispheres. The only study located, quoting similar results, that is a smaller tendency to commit reversal errors in Mixed dominant subjects, was carried out by Krise in 1952, and he was unable to explain the finding. The present writer must also admit to inability to find an adequate explanation for the finding. The best that can be done is to say that although it was significant, the result was due to chance rather than the existence of a real relationship.

The Relationship Between Laterality and Left-Right Discrimination

Tables XX, XXI and XXII reveal that the ability to discriminate right and left on the Benton A, B and C is independent of lateral preference. There is no significantly greater incidence of Left, Right, or Incomplete handedness, eyedness or footedness in Discriminating or Confused groups. Table XXIII indicates no relationship between handedness or eyedness and the ability to discriminate on the Non-Verbal test. However, Table XXIII shows that footedness and discrimination on the Non-Verbal test are not independent - chi-square is significant at the .01 level. Inspection of the expected values for each cell shows that left-footed individuals tend to be Confused on the Non-Verbal test. Hence left foot preference seems to be associated with more difficulty in directional orientation. This may be taken as evidence to support the viewpoint that individuals with left preference are confused in left-right awareness because their dominant hemisphere indicates that they should be using their right side, i.e. many left-footed individuals are left cerebral dominant. However, this is hard to accept since no relationship between handedness or eyedness and discrimination was apparent. Nor was there any evidence of more lack of ability to discriminate in subjects who were Inconsistent on the Extensibility Test compared to those who were Consistent (See Table XXIV). Inconsistent subjects are said to be using a different hand preference to that indicated by their cerebral dominance pattern. In view of the large body of evidence in this study indicating a lack of relationship between handedness, eyedness or footedness and left-right discrimination, it seems probable that the significant relationship found between footedness and discrimination on the Non-Verbal

TABLE XX

CONTINGENCY TABLES SHOWING RELATIONSHIP BETWEEN HANDEDNESS,
EYEDNESS AND FOOTEDNESS AND DISCRIMINATION
ON BENTON A

Handedness:

df = 4	Left	Right	Mixed	Total
Discriminating	4 (4.5)	24 (24)	2 (1.5)	30
Confused	5 (3.6)	18 (19.2)	1 (1.2)	24
Consistently Reversing	0 (.9)	6 (4.8)	0 (.3)	6
Total	9	48	3	60

Chi-Square = 2.956

Footedness:

df = 4	Left	Right	Mixed	Total
Discriminating	3 (4.1)	26 (25.3)	2 (1.6)	31
Confused	5 (3)	17 (18.8)	1 (1.2)	23
Consistently Reversing	0 (.8)	6 (4.9)	0 (.3)	6
Total	8	49	3	60

Chi-Square = 3.28

TABLE XX
(Continued)

Eyedness:

df = 4	Left	Right	Mixed	Total
Discriminating	9 (9.5)	21 (19.5)	0 (1)	30
Confused	6 (7.6)	16 (15.6)	2 (.8)	24
Consistently Reversing	4 (1.9)	2 (3.9)	0 (.2)	6
Total	19	39	2	60

Chi-Square = 4.984

TABLE XXI

CONTINGENCY TABLES SHOWING RELATIONSHIPS BETWEEN HANDEDNESS,
EYEDNESS AND FOOTEDNESS AND DISCRIMINATION
ON THE BENTON B

Handedness:

df = 2	Left	Right	Mixed	Total
Discriminating	1 (2)	16 (14.1)	0 (.9)	17
Confused	6 (5.1)	34 (35.8)	3 (2.1)	43
Total	7	50	3	60

Chi-Square = 2.45

Footedness:

df = 2	Left	Right	Mixed	Total
Discriminating	0 (2.3)	15 (13.8)	2 (.9)	17
Confused	8 (5.6)	34 (33.2)	1 (2.0)	43
Total	8	49	3	60

Chi-Square = 3.38

TABLE XXI
(Continued)

Eyedness:

df = 2	Left	Right	Mixed	Total
Discriminating	8 (5.8)	9 (7.2)	0 (.5)	17
Confused	11 (13.6)	30 (27.9)	2 (1.4)	43
Total	19	39	2	60

Chi-Square = 2.04

TABLE XXII

CONTINGENCY TABLES SHOWING RELATIONSHIP BETWEEN HANDEDNESS,
EYEDNESS AND FOOTEDNESS AND DISCRIMINATION
ON THE BENTON C

Handedness:

df = 2	Left	Right	Mixed	Total
Discriminating	0 (.2)	2 (1.6)	0 (.1)	2
Confused	7 (6.7)	48 (48.3)	3 (2.9)	58
Total	7	50	3	60

Chi-Square = 0.415

Footedness:

df = 2	Left	Right	Mixed	Total
Discriminating	0 (.2)	2 (1.6)	0 (.1)	2
Confused	8 (7.4)	47 (39.2)	3 (2.9)	58
Total	8	49	3	60

Chi-Square = 0.420

TABLE XXII
(Continued)

Eyedness:

df = 2	left	Right	Mixed	Total
Discriminating	1 (.6)	1 (1.3)	0 (.1)	2
Confused	18 (18.2)	38 (37.7)	2 (1.9)	58
Total	19	39	2	60

Chi-Square = 0.749

TABLE XXIII

CONTINGENCY TABLES SHOWING RELATIONSHIP BETWEEN HANDEDNESS,
FOOTEDNESS AND EYEDNESS AND DISCRIMINATION
ON THE NON-VERBAL TEST

Handedness:				
df = 2	Left	Right	Mixed	Total
Discriminating	1 (3.3)	27 (24.1)	1 (1.4)	29
Confused	6 (3.6)	23 (25.8)	2 (1.5)	31
Total	7	50	3	60

Chi-Square = 4.13

Footedness:

df = 2	Left	Right	Mixed	Total
Discriminating	0 (3.8)	28 (23.8)	1 (1.4)	29
Confused	8 (4.0)	21 (25.1)	2 (1.5)	31
Total	8	49	3	60

Chi-Square = 9.70**

TABLE XXIII
(Continued)

Eyedness:

df = 2	Left	Right	Mixed	Total
Discriminating	12 (9.1)	17 (18.7)	0 (.9)	29
Confused	7 (9.8)	22 (20.1)	2 (1.1)	31
Total	19	39	2	60

Chi-Square = 3.96

Crossed and Established:

	Crossed	Established	Total
Discriminating	11 (11.5)	18 (18.3)	29
Confused	12 (11.5)	19 (18.3)	31
Total	23	37	

Chi-Square = .07

test is a chance effect without importance.

Table XXIV provides strong evidence that established dominant subjects are superior in the ability to discriminate right and left on their own bodies. Crossed dominant subjects scored significantly lower (at the .01 level) on the Benton A and Benton Total and (at the .05 level) they scored lower on the Non-Verbal C.

The finding, that subjects who do not show a consistent preference for one side of the body are less able to discriminate right

TABLE XXIV

T-TESTS COMPARING CROSSED AND ESTABLISHED DOMINANT
AND CONSISTENT AND INCONSISTENT ON THE
BENTON AND NON-VERBAL

Crossed and Established Dominant groups on Benton and Non-Verbal Scores:

	N	MEANS	S.D.	T	P
<u>Benton A:</u>					
Crossed	22	13.64	9.01	-2.824	0.006**
Established	38	19.47	6.62		
<u>Benton B:</u>					
Crossed		1.55	1.64	-0.30	0.76
Established		1.68	1.76		
<u>Benton C:</u>					
Crossed		0.95	1.07	-0.50	0.62
Established		1.11	1.14		
<u>Benton Total:</u>					
Crossed		16.14	9.04	-2.84	0.006**
Established		22.26	7.21		
<u>Non-Verbal A:</u>					
Crossed		9.82	0.65	-0.15	0.88
Established		9.84	0.54		
<u>Non-Verbal B:</u>					
Crossed		2.18	2.60	-0.44	0.66
Established		2.50	2.70		
<u>Non-Verbal C:</u>					
Crossed		11.36	1.46	-2.50	0.02**
Established		11.97	0.16	(T'=1.95)	(0.06)
<u>Non-Verbal Total:</u>					
Crossed		23.36	3.51	-103	0.31
Established		24.21	2.69		

TABLE XXIV
(Continued)

Consistent and Inconsistent on Non-Verbal Scores:

	N	MEANS	S.D.	T	P
<u>Non-Verbal A:</u>					
Consistent	42	9.76	0.68	-1.45	0.15
Inconsistent	18				
<u>Non-Verbal B:</u>					
Consistent		2.26	2.57	-0.53	0.59
Inconsistent		2.67	2.87		
<u>Non-Verbal C:</u>					
Consistent		11.69	1.10	-0.74	0.46
Inconsistent		11.89	0.31		
<u>Non-Verbal Total:</u>					
Consistent		23.67	3.01	-0.89	0.37
Inconsistent		24.44	3.04		

and left at the stage one level, is very interesting. It is possible that established lateral preference, rather than having a direct effect on reading, influences the development of left-right awareness, which in its turn contributes to reading skill. The evidence in this study does not support Orton's neurological explanation of reading disability, but it is supportive of Benton's point of view, namely that the preferential use of one side of the body affects the development of a "body schema" which in turn influences the growth of left-right awareness. It appears from the present study that, as Benton argued, it is the early stages of left-right awareness that are related to the development of the "body gradient" (if established laterality can be taken as evidence of the existence of a developed "body gradient").

Relationship Between Lateral Dominance and Verbal Ability

Table XXV and XXVI do not reveal any significant association between any type of lateral dominance and W.I.S.C. vocabulary scores. Orton argued that reading disability was a specific manifestation of a general language disorder caused by anomalies of dominance. The present study gives no support to this viewpoint.

Relationship Between Lateral Dominance and Visual-Perceptual Ability

Table XXVII shows no significant relationship between Eyedness and Footedness and Visual-Perceptual Ability, but a highly significant relationship (at beyond the .01 level) between Handedness and performance on the Frostig V (Spatial Relations) is apparent. The Newman-Keuls test shows that right-handed subjects had the highest score on the Frostig V, left-handed subjects an intermediate score and incomplete-handed subjects the lowest score. Left and right handed subjects were significantly superior to incomplete-handed subjects but right-handers were not significantly superior to left-handers in their Frostig V scores. This data provides evidence that Incomplete-handed individuals are poorer in the Visual-Perceptual ability of discriminating Spatial Relationships than individuals with Established handedness.

Similarly, Table XXVIII indicates that Crossed Dominant subjects scored lower on the Frostig V than did Established Dominant subjects. The Frostig V involves the copying of geometric patterns, a skill which seems to involve not only motor skills but the perception of direction in space. Again, lateral dominance appears to be related to a skill not unlike right-left orientation. The motor component in the Frostig V could also be

TABLE XXV

THE EFFECT OF HANDEDNESS, FOOTEDNESS AND EYEDNESS
ON W.I.S.C. VOCABULARY

Handedness:

Summary of Analysis of Variance on W.I.S.C. Vocabulary Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	72.95	2	36.48	1.41	0.25
Within Groups	1479.78	57	25.96		

Footedness:

Summary of Analysis of Variance on W.I.S.C. Vocabulary Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	49.84	2	24.92	0.95	0.39
Within Groups	1502.89	57	26.37		

Eyedness:

Summary of Analysis of Variance on W.I.S.C. Vocabulary Scores:

Source of Variance	SS	df	MS	F	P
Between Groups	94.20	2	47.10	1.84	0.16
Within Groups	1458.52	57	25.59		

TABLE XXVI
 CROSSED AND ESTABLISHED DOMINANCE, EXTENSIBILITY
 AND VERBAL ABILITY

	N	MEANS	S.D.	T.	P
W.I.S.C. Vocabulary					
Crossed	22	18.18	5.69	0.86	0.39
Established					
Established	38	17.00	4.65		
W.I.S.C. Vocabulary					
Consistent	42	17.55	5.30	0.26	0.79
Inconsistent	18	17.17	4.54		

TABLE XXVII

THE EFFECT OF HANDEDNESS, EYEDNESS AND FOOTEDNESS
ON VISUAL-PERCEPTUAL ABILITY

Handedness:

Summary of Analysis of Variance on Frostig Scores:

Source of Variance	SS	df	MS	F	P
<u>Frostig I:</u>					
Between Groups	9.66	2	4.83	0.28	0.75
Within Groups	990.51	57	17.38		

<u>Frostig II:</u>					
Between Groups	0.28	2	0.14	0.01	0.98
Within Groups	581.90	57	10.21		

<u>Frostig III:</u>					
Between Groups	46.10	2	23.05	1.74	0.18
Within Groups	754.88	57	13.24		

<u>Frostig IV:</u>					
Between Groups	2.61	2	1.31	0.76	0.47
Within Groups	98.32	57	1.72		

<u>Frostig V:</u>					
Between Groups	18.57	2	9.29	7.83	0.00099**
Within Groups	67.60	57	1.19		

TABLE XXVII
(Continued)Newman-Keuls on Means:

Means	2	1	3
	6.42	5.71	4.00

3	2.42**	1.71**
1	0.71	
2		

Group 1 - Left-handed
Group 2 - Right-handed
Group 3 - Mixed-handed

	SS	df	MS	F	P
<u>Frostig Total:</u>					
Between Groups	0.23	2	117.31	1.34	0.27
Within Groups	0.56	57	87.77		

Eyedness:Summary of Analysis of Variance on Frostig Scores:

Source of Variance	SS	df	MS	F	p
<u>Frostig I:</u>					
Between Groups	2.37	2	1.18	0.07	0.93
Within Groups	997.8	57	17.51		

Frostig II:

Between Groups	4.78	2	2.39	0.24	0.79
Within Groups	577.41	57	10.13		

Frostig III:

Between Groups	39.60	2	19.80	1.48	0.23
Within Groups	761.4	57	13.36		

TABLE XXVII
(Continued)

Source of Variance	SS	df	MS	F	P
<u>Frostig IV:</u>					
Between Groups	5.24	2	2.62	1.56	0.22
Within Groups	95.70	57	1.68		
<u>Frostig V:</u>					
Between Groups	6.10	2	3.05	2.17	0.12
Within Groups	80.08	57	1.40		
<u>Frostig Total:</u>					
Between Groups	81.88	2	40.94	0.45	0.64
Within Groups	5155.88	57	90.45		
Footedness:					
Summary of Analysis of Variance on Frostig Scores:					
Source of Variance	SS	df	MS	F	P
<u>Frostig I:</u>					
Between Groups	3.91	2	1.95	0.11	0.89
Within Groups	996.28	57	17.48		
<u>Frostig II:</u>					
Between Groups	6.41	2	3.21	0.32	0.73
Within Groups	575.77	57	10.10		

TABLE XXVII
(Continued)

Source of Variance	SS	df	MS	F	P
<u>Frostig III:</u>					
Between Groups	7.21	2	3.61	0.26	0.77
Within Groups	793.76	57	13.93		
<u>Frostig IV:</u>					
Between Groups	5.08	2	2.54	1.79	0.17
Within Groups	81.10	57	1.42		
<u>Frostig Total:</u>					
Between Groups	98.38	2	49.19	0.55	0.58
Within Groups	5139.38	57	90.16		

influenced by the existence of a right-left body gradient which Benton postulates to be important in both lateral dominance and left-right awareness. At any rate, this study is supportive of a relationship between Mixed Dominance and ability to perceive spatial relations in a visual task.

Summary of Findings

1. The performance on tests of left-right discrimination by the children in this sample indicates that about two-thirds of them have acquired the ability to discriminate right and left from their own viewpoint. Hence, the greater proportion of the sample had achieved stage

TABLE XXVIII

CROSSED AND ESTABLISHED DOMINANCE, EXTENSIBILITY AND
VISUAL-PERCEPTUAL ABILITY

Crossed and Established Dominance and Frostig Scores:

	N	MEANS	S.D.	T	P
<u>Frostig I:</u>					
Crossed	22	20.95	3.44	-0.47	0.64
Established	38	21.47	4.40		
<u>Frostig II:</u>					
Crossed		11.86	2.80	-1.43	0.16
Established		13.05	3.20		
<u>Frostig III:</u>					
Crossed		8.36	3.48	0.28	0.78
Established		8.08	3.74		
<u>Frostig IV:</u>					
Crossed		6.27	1.48	-0.87	0.39
Established		6.58	1.16		
<u>Frostig V:</u>					
Crossed		5.77	1.28	-2.23	0.03*
Established		6.47	1.07		
<u>Frostig Total:</u>					
Crossed		53.14	8.37	-0.99	0.32
Established		55.66	9.74		

Consistent and Inconsistent Subjects on Frostig:

	N	MEANS	S.D.	T	P
<u>Frostig I:</u>					
Consistent	42	21.50	4.19	0.62	0.53
Inconsistent	18	20.78	3.76		
<u>Frostig II:</u>					
Consistent		13.10	2.99	1.84	0.07
Inconsistent		11.50	3.11		

TABLE XXVIII
(Continued)

	N.	MEANS	S.D.	T.T.	P
<u>Frostig III:</u>					
Consistent		8.43	3.49	0.79	0.44
Inconsistent		7.61	3.96		
<u>Frostig IV:</u>					
Consistent		6.50	1.20	0.30	0.77
Inconsistent		6.39	1.50		
<u>Frostig V:</u>					
Consistent		6.40	1.05	1.88	0.07
Inconsistent		5.78	1.40		
<u>Frostig Total</u>					
Consistent		55.88	9.25	1.46	0.15
Inconsistent		52.05	9.00		

one left-right awareness. A relatively small proportion of subjects, about one quarter, were able to discriminate right and left on a representation of a person, so a minority of the subjects in this sample had achieved stage two left-right awareness. In a double transposition task involving both own viewpoint and that of a picture of a man, only two subjects were totally successful indicating that stage three left-right awareness is relatively undeveloped in grade one children.

2. The Non-Verbal tasks of indicating the direction of objects in a picture, and copying nonsense syllables containing easily reversible letters was easily achieved by a large majority of children in this sample. However, the task of copying of model's lateral body movements was a good deal more difficult and was accomplished by only a few of the subjects.

3. The present sample appears to have largely acquired the preferential use of one hand, eye and foot, since only about one twentieth of them were incomplete-handed and footed while a thirtieth was incomplete eyed. The proportion of left-handed and left-footed individuals was roughly one tenth of the sample, but there were about a third left-eyed individuals in the sample. Approximately a third of the sample used the opposing eye to their dominant hand, while two-thirds showed a unilateral preference for one side of the body.

4. A strong positive relationship between the Benton A and Non-Verbal subtests A and C indicated some overlap in what these subtests measure, namely the ability to discriminate right and left from one's own point of view.

5. The ability to discriminate right from left on one's own body even without the ability to correctly label these directions, was found to be related to reading achievement. When the effect of Verbal ability was partialled out of left-right discrimination by Covariance, a relationship between left-right awareness was still found. Subjects who made reversal errors on the Neale scored lower on the Benton A while they scored higher on the Benton B.

6. Verbal ability was greater in subjects who were able to discriminate right and left on their own body (on the Benton and the Non-Verbal Test). No relationship between left-right discrimination at stages two and three was found with verbal ability.

7. The Visual-Perceptual ability of discriminating Position in Space is significantly related to left-right awareness at the stage one level (Benton A), while Eye-Motor Coordination and Position in Space are

significantly related to the Stage two (Benton B) level of left-right awareness. The Non-Verbal tests A and C are significantly related to Figure-Ground Discrimination, Spatial Relations, Position in Space and Eye-Motor Coordination.

8. No significant relationship between reading achievement scores and any type lateral dominance was found but a smaller proportion of crossed dominant than established dominant made reversal errors in reading.

9. Subjects who were left-footed scored lower on the Non-Verbal test but there were no other relationships between Handedness, Eyedness and Footedness and left-right discrimination. Crossed dominant subjects scored significantly lower on the Benton A than did established dominant subjects indicating that established laterality is related to the ability to discriminate right from left from one's own point of view.

10. No relationship between lateral dominance and verbal ability was found but right-handed and left-handed subjects performed significantly better on the Frostig Spatial Relations test than Incomplete-handed subjects. Also crossed dominant subjects were inferior to established dominant subjects on the Spatial Relations test. Hence lack of established dominance is again shown to be associated with poorer ability in spatial orientation.

CHAPTER V

SUMMARY, CONCLUSIONS AND IMPLICATIONS

I. SUMMARY

The main purpose of this study was to investigate the relationship between left-right discrimination and reading in a sample of sixty grade one children. In addition the study examined whether left-right discrimination was associated with lateral dominance, and whether lateral dominance influenced reading achievement. The nature of left-right discrimination and lateral dominance was explored by looking at their relationships with verbal and visual-perceptual skills in the sample.

The ability to discriminate right and left was assessed with two tests - the Benton Test of Right-Left Discrimination and the Non-Verbal Test of Directional Orientation. The former test was developed by Benton and consists of three parts - the first requires the child to identify his own lateral body parts, the second requires him to identify the lateral body parts of a picture of a man, and the third requires him to identify simultaneously his own lateral body parts and that of a picture of a man. The Non-Verbal test was developed for this study in an attempt to reduce the importance of labelling ability in the measurement of left-right directional discrimination. All three subtests omitted the use of the terms "right" and "left". The first subtest involved the subject in identifying the direction of objects in a picture with the appropriate hand, the second subtest required the subject to imitate a model's movements as he put a hand on the lateral body parts of a picture of a man, and the third necessitated the child copying nonsense syllables made up

of easily reversible letters.

The Harris Tests of Lateral Dominance were used to measure the child's laterality status and the Extensibility test (extension of the arms with fingers extended) was included as an attempt to measure cerebral dominance. Reading ability was assessed by the Accuracy score on the Neale Analysis of Reading Ability, verbal ability by the W.I.S.C. vocabulary and visual-perceptual ability by the Frostig Developmental Test of Visual Perception.

II. FINDINGS AND CONCLUSIONS

Hypothesis 1

A. There is no significant correlation between scores on the Neale and:

- a) Scores on the Benton.
- b) Scores on the Non-Verbal Test.

B. There is no significant difference between the Neale scores if:

- a) Confused, Discriminating and Consistently Reversing subjects on the Benton A.
- b) Confused and Discriminating subjects on the Benton B.
- c) Confused and Discriminating subjects on the Benton C.
- d) Confused and Discriminating subjects on the Non-Verbal test.

C. There is no significant difference between the Benton scores of subjects who make reversal errors on the Neale and those who do not.

D. There is no significant difference in the Non-Verbal scores of subjects who make reversal errors on the Neale and those who do not.

Aa) This hypothesis is rejected for subtest A and subtest C of the Benton. There was a significant positive correlation between the Benton A and the Neale at the .05 level and a significant negative correlation between the Benton C and the Neale at the .05 level. However, the correlations between the Benton B and the Neale and the Benton Total and

the Neale did not achieve statistical significance.

b) This hypothesis is rejected for subtest A of the Non-Verbal test since there was a positive correlation significant at the .05 level between the Non-Verbal A and the Neale. There were not any significant correlations between the Neale and the subtests B, C, and Total score on the Non-Verbal test.

Ba) This hypothesis is rejected since the analysis of variance indicates that Confused, Consistently Reversing and Discriminating groups on the Benton A differ significantly in their Neale scores. The significance achieved is beyond the .01 level. A Newman-Keuls test revealed that the Discriminating group had a Neale mean which was significantly superior to the Confused group, but that the Consistently Reversing groups, which had a mean which was intermediate between the other two groups, did not differ significantly from the Discriminating group or the Confused group. An analysis of covariance on adjusted means with verbal ability as the covariate and Neale scores as the criterion gave further evidence to support rejection of this hypothesis since a significant difference at beyond the .05 level exists between the Neale scores of the three groups. The analysis suggests that even when verbal ability is partialled out a relationship between confusion on the Benton A and reading achievement exists.

b)c)d) These hypotheses are not rejected since t-tests revealed that the Discriminating and Confused groups on the Benton B, Benton C and Non-Verbal tests did not differ significantly in their Neale scores.

C. This hypothesis is rejected for subtests A and B of the Benton since t-tests show that subjects who made reversal errors scored significantly lower at the .05 level than subjects who did not make

reversal errors on the Benton A, and that reversing subjects scored significantly higher on the Benton B than non-reversing subjects. Scores on subtest C and Total score of the Benton did not differ significantly among reversing and non-reversing subjects.

D. This hypothesis is not rejected since Non-Verbal scores on A, B, C and Total did not differ significantly among reversing and non-reversing subjects.

Conclusion

The data indicate support for the first research hypothesis suggesting that reading achievement is associated with left-right discrimination. This study provides evidence which indicates that the ability to discriminate right and left from the child's own viewpoint, with or without the ability to correctly label right or left is associated with greater success in reading as well as fewer errors of reversal in reading. The findings for the Benton B or stage two left-right awareness conflict with the research hypothesis since they indicate that high scorers on the Benton B were low scorers on the Neale, and that the mean on the Benton B of subjects who made reversal errors was higher than those who did not. The writer has suggested in Chapter IV that this result may be a statistical artifact.

Hypothesis 2

A. There is no significant correlation between Frostig scores and:

- a) Benton scores.
- b) Non-Verbal scores.

B. There is no significant difference between the Frostig scores of:

- a) Confused, Discriminating and Consistently Reversing subjects on the Benton A.
- b) Confused and Discriminating subjects on the Benton B.
- c) Confused and Discriminating subjects on the Benton C.
- d) Confused and Discriminating subjects on the Non-Verbal test.

Aa) This hypothesis is not rejected since there were no significant correlations between any Frostig and Benton scores.

b) This hypothesis is rejected since there are significant positive correlations between:

- i) Frostig IV and Non-Verbal A (.01 level).
- ii) Frostig IV and Non-Verbal C (.01 level).
- iii) Frostig V and Non-Verbal C (.05 level).
- iv) Frostig II and Non-Verbal Total (.05 level).
- v) Frostig Total and Non-Verbal Total (.05 level).

Ba) This hypothesis is rejected for the Frostig IV. Confused, Discriminating and Consistently Reversing subjects on the Benton A had significantly different means on the Frostig IV at beyond the .01 level. Consistently Reversing subjects were significantly superior to Confused subjects in their Frostig IV scores. That is, reversing subjects were better able to determine position in space than confused subjects.

b) This hypothesis is rejected for the Frostig I since the Confused group on the Benton B scored significantly lower at the .01 level than the Discriminating group. The hypothesis is also rejected for the Frostig IV since subjects who were confused on the Benton B scored significantly lower at the .05 level than Discriminating subjects.

c) This hypothesis is not rejected. There are significant differences between the Frostig scores of Confused and Discriminating subjects on the Benton C.

d) This hypothesis is not rejected. There are no significant differences between the Frostig scores of Confused and Discriminating subjects on the Non-Verbal test.

Conclusion

The research hypothesis that left-right discrimination ability is related to visual-perceptual skills is supported by this study. It appears that subjects who are more competent in left-right discrimination, verbally or non-verbally, have better Visual-Perceptual ability. The only measure of left-right discrimination which did not show any relationship to visual-perception was the Benton C which measures ability to locate the lateral body parts of a model and on one's own body. The ability is the most difficult in left-right discrimination but the data may indicate a genuine lack of relationship between stage three left-right awareness and visual-perception. However, it is not possible to make this conclusion since only a very small minority of the sample had achieved stage three left-right awareness. In other words, the ability is largely undeveloped in the present sample so an older sample would be needed to test whether a relationship between visual-perception and stage three left-right awareness exists.

Hypothesis 3

A. There is no significant correlation between W.I.S.C. vocabulary scores and:

- a) Benton scores.
- b) Non-Verbal scores.

B. There is no significant difference between the W.I.S.C. vocabulary scores of:

- a) Confused, Consistently Reversing and Discriminating subjects on

the Benton A.

- b) Confused and Discriminating groups on the Benton B.
- c) Confused and Discriminating groups on the Benton C.
- d) Confused and Discriminating groups on the Non-Verbal test.

Aa) This hypothesis is not rejected since the correlation between the Benton and W.I.S.C. vocabulary scores were not significant.

b) This hypothesis is rejected since there is a significant positive correlation at the .05 level between Non-Verbal Total scores and W.I.S.C. vocabulary scores.

Ba) This hypothesis is rejected since Confused, Consistently Reversing and Discriminating groups on the Benton A had means which differed significantly at the .01 level. The Consistently Reversing group scored significantly higher than the Confused group on the W.I.S.C. vocabulary but did not differ significantly from the Discriminating group.

b)c)d) These hypotheses are not rejected since there were no significant differences between the W.I.S.C. vocabulary scores of Confused and Discriminating subjects on the Benton B, C or Non-Verbal test.

Conclusion:

The research hypothesis that left-right discrimination is related to verbal ability is partly confirmed since children who discriminated more efficiently between right and left from their own viewpoint (even without the ability to correctly label left and right) tended to score higher on the W.I.S.C. vocabulary. This study supports a relationship between left-right discrimination, particularly from the child's own viewpoint, and verbal ability. Although no relationship between Benton B or Benton C and verbal ability appeared in this sample, it is not

possible to conclude definitely that verbal ability plays no part in stage two and three left-right awareness since these skills were relatively undeveloped in this sample.

Hypothesis 4

There is no significant correlation between Benton and Non-Verbal test scores.

This hypothesis is rejected since the following significant positive correlations between the Benton and Non-Verbal test were found:

- i) Benton A and Non-Verbal A (at .05 level)
- ii) Benton A and Non-Verbal C (at .05 level).
- iii) Benton Total and Non-Verbal A (at .01 level).
- iv) Benton Total and Non-Verbal C (at .05 level).

Conclusion

This study supports the view that left-right discrimination which requires verbal labels is associated with left-right discrimination which does not require such labels. In terms of the particular subtests it appears that the Non-Verbal A and Non-Verbal C require similar skills to the Benton A, namely the ability to discriminate between right and left from the child's own viewpoint.

Hypothesis 5

A. There is no significant difference in the Neale scores of subjects who have Crossed Dominance and subjects who have Established Dominance.

B. There is no significant difference in the Neale scores of subjects who have Incomplete Dominance and subjects who have Established Dominance.

C. There is no significant difference in the Neale scores of

subjects who are Consistent and Inconsistent on the Extensibility test.

D. There is no significant difference in the proportion of subjects who have Crossed Dominance and make reversal errors on the Neale and the proportion of subjects who have Established Dominance and make reversal errors.

E. There is no significant difference in the proportion of subjects who have Established Dominance and make reversal errors and the proportion of subjects who have Incomplete Dominance and make reversal errors.

F. There is no significant difference in the proportion of subjects who are Consistent on the Extensibility test and make reversal errors and the proportion of subjects who are Inconsistent and make reversal errors.

A. This hypothesis is not rejected since there was no significant difference in the Neale scores of Crossed and Established Dominant subjects.

B. This hypothesis is not rejected since there were no significant differences in the Neale scores of left- right and incomplete handed, footed or eyed subjects.

C. This hypothesis is not rejected since there was no significant difference in the Neale scores of Consistent and Inconsistent subjects.

D. This hypothesis is rejected. A chi-square on the contingency table of crossed and established dominance and reversals and non-reversals was significant at the .05 level. The data indicates that fewer crossed dominant subjects made reversal errors than established dominant subjects.

E. This hypothesis is not rejected since chi-square on the contingency tables for handedness, footedness, eyedness and reversals were not significant.

F. This hypothesis is not rejected since chi-square for the contingency table of consistency and inconsistency and reversals was non-significant.

Conclusion

The data concerning the relationship between laterality and reading achievement indicates that there is no relationship between the two factors. Hence it appears that the research hypothesis which suggests that Established dominant subjects will be better readers should be denied. However, the data on Reversal errors does indicate one significant relationship, namely that Crossed dominant subjects are less likely to make reversal errors in reading. Since this relationship runs counter to the majority of the literature, the writer is hesitant to conclude definitely that Crossed Dominant subjects have a smaller tendency to make reversal errors in reading. It seems likely that the chi-square is one of the few false positives which occur by chance. However, more research would be needed to make a categorical conclusion on this point.

Hypothesis 6

- A. There is no significant difference between the means of the Established and Crossed Dominant subjects on:
 - a) the Benton.
 - b) the Non-Verbal test.

- B. There is no significant difference between the proportion of Incomplete and Established Dominant subjects who are:
 - a) Discriminating, Confused or Consistently Reversing on the Benton A.
 - b) Discriminating or Confused on the Benton B.
 - c) Discriminating or Confused on the Benton C.
 - d) Discriminating or Confused on the Non-Verbal test.

Aa) This hypothesis is rejected since the means of Crossed Dominant subjects on the Benton A and the Benton Total are significantly lower at beyond the .01 level than the means of Established dominant subjects.

- b) This hypothesis is rejected since the means on the Non-Verbal C

of Crossed Dominant subjects were significantly lower than the means of the Established dominant subjects.

Ba) This hypothesis is not rejected since chi-square is not significant for the contingency tables of discrimination on the Benton A versus Handedness, Footedness or Eyedness.

b) This hypothesis is not rejected since chi-square for the contingency table of discrimination on the Benton B versus Handedness, Footedness or Eyedness is not significant.

c) This hypothesis is not rejected since chi-square for the contingency table of discrimination on the Benton C versus Handedness, Footedness or Eyedness is not significant.

d) This hypothesis is not rejected since chi-square for the contingency tables of Incomplete or Established Handedness, Eyedness or Footedness versus discrimination on the Non-Verbal Test were insignificant.

Conclusion

The research hypothesis proposing that subjects with Established dominance will tend to be more efficient in discriminating right and left is partially confirmed. The data indicate that crossed dominant subjects are poorer in the ability to discriminate right and left on their own body, verbally and non-verbally, and poorer in their overall ability to discriminate right and left. However, the data did not indicate any difference between established and incomplete dominant subjects in their ability to discriminate right and left.

Research Hypothesis 7 :

- A. There is no significant difference in the Frostig scores of:
- a) subjects who have Crossed Dominance and subjects who have Established Dominance.
 - b) subjects who have Incomplete Dominance and subjects who have Established Dominance.
 - c) subjects who are Consistent on the Extensibility test and subjects who are Inconsistent.

Aa) This hypothesis is rejected for the Frostig V since Crossed Dominant subjects scored significantly lower (at the .05 level) than Established Dominant subjects on the Frostig V.

b) This hypothesis is rejected since Incomplete handed subjects scored significantly lower on the Frostig V than right and left-handers at beyond the .01 level. The hypothesis is not rejected for eyedness and footedness because there were no significant differences in the Frostig scores of Incomplete and Established eyed and footed subjects.

c) This hypothesis is not rejected since there is no significant difference between the Frostig scores of Consistent and Inconsistent subjects.

Conclusion:

The research hypothesis that subjects with Established dominance have more Visual-perceptual ability is partially confirmed. Established dominant subjects were found to be superior to both Crossed and Incomplete (for handedness) subjects in one particular Visual-Perceptual ability, namely Spatial Relations.

Research Hypothesis 8

A. There is no significant difference in the W.I.S.C. vocabulary scores of:

- a) subjects who have Crossed Dominance and subjects who have Established Dominance.
- b) subjects who have Incomplete Dominance and subjects who have Established Dominance.
- c) subjects who are Consistent on the Extensibility test and subjects who are Inconsistent.

Aa)b)c) These hypotheses are not rejected since there were no significant differences between the W.I.S.C. vocabulary scores of Crossed and Established dominant subjects, Incomplete and Established dominant subjects or Consistent and Inconsistent subjects.

Conclusion

The research hypothesis that subjects with Established Dominance will have more verbal ability is not supported by the data. There appears to be no relationship between laterality and verbal ability.

IMPLICATIONS

Theoretical

The results of the present investigation suggest that stage one left-right discrimination does play an important part in early reading achievement. Past studies (cited in Chapter II) indicated that there are a greater number of disturbances in left-right discrimination in children with reading disability, but such studies have either involved the comparison of normal and retarded readers or have used samples of older children. The present sample was a group of normal grade one children who had received only about seven months of reading instruction. The data in this

study indicate that those children who are more accurate readers are better able to discriminate right and left on their own bodies. The finding of such a relationship in normal children suggests that confusion in left-right awareness is a developmental problem rather than a neurological problem.

The present study throws some light on the nature of stage one left-right awareness but is less clear-cut on the nature of stage two and three left-right awareness, probably because the former skill was well-developed within the sample while the latter skill was largely undeveloped especially at stage three. The study supports those writers (Fellows, Templeton, Vernon) who regard left-right discrimination as a verbally-based cognitive skill. The verbal basis of left-right discrimination appears to involve more than labelling ability. Not only did Consistently Reversing subjects do just as well in reading achievement as Discriminating subjects but they did as well as (in fact slightly but not significantly better than) Discriminating subjects in verbal ability and visual-perceptual ability. It appears, therefore that left-right discrimination may involve verbal mediation of a more complex nature than labelling. The fact that children who were better at Non-Verbal left-right discrimination were also better on the W.I.S.C. vocabulary adds weight to this argument. Benton is of the opinion that stage two and stage three left-right discrimination are heavily language-based but not stage one. The present study does not give conclusive evidence about stages two and three but it does suggest a strong positive relationship between stage one left-right awareness, the ability to discriminate right and left from the child's own viewpoint, and verbal ability. The present study does not

support a further argument of Benton, namely that subjects who consistently reverse right and left are defective in language skills. Such subjects were equal to discriminating subjects who could correctly label right and left, not only in reading ability but in verbal ability. The strong evidence of a verbal-cognitive component in left-right discrimination, even at its most elementary level, may explain why the achievement of left-right awareness is so difficult for young children and why its development lags behind other perceptual skills.

That left-right discrimination is also a perceptual skill is supported by this investigation. Relationships between visual-perceptual ability and left-right discrimination were clearly evident, especially at the stage one level. When verbal ability was statistically controlled by analysis of covariance, left-right discrimination was related to reading. The relationship may well be due to the perceptual component in left-right discrimination. Benton (1959) views left-right discrimination as related to the development of a "left-right gradient" of the body.

On a conscious level, the two sides of the body are felt as different from each other, although it is impossible, at least for most people, to specify the nature of the difference in verbal terms (Benton, 1959, p. 141).

This gradient, Benton views as composed of somesthetic components - tactual and proprioceptive - as well as visual component. This study gives results which are not at variance with Benton's body-gradient notion. The results indicated a relationship between left-right discrimination, lateral dominance and visual perception. In addition there was indirect evidence to support a somesthetic component in left-right discrimination, that is that children who had a strong preference for one hand or for the consistent use of one side of the body were better discriminators of right and left.

The relationship found between lateral dominance and left-right discrimination is thus convincingly explained in terms of body schema. Children who feel different parts of their body as different will be more likely to have a strong preference for one side of the body, which in turn will be associated with better ability to identify the lateral body parts.

The neurological explanation of an association between left-right awareness and laterality as expounded by Orton (1937) is not supported by this study. Both confusion in left-right awareness and lack of established cerebral dominance were regarded by Orton as evidence of conflict between the two hemispheres which would tend to lead to reading and other symbolic disorders. However, no clear relationship between lack of established cerebral or lateral dominance and reading disorders was found in this study, nor did subjects without established dominance have poorer verbal ability. Moreover, a period of confusion in left-right discrimination could be regarded as a developmental stage since it existed in many of the children in this normal sample. When another supposed measure of cerebral dominance was used, the Extensibility test, there was still no evidence of any relationship between cerebral dominance and reading ability or verbal ability.

A much more plausible theoretical explanation of the data in this study concerning lateral dominance and left-right discrimination is offered by Benton's body-gradient approach. The present writer is much more inclined to accept a developmental functional association between laterality and left-right discrimination and between reading and left-right discrimination than a neurological association.

Practical

1. The study suggests that the development of skill in discriminating between right and left is based on verbal, perceptual and somesthetic factors developed before school age. This implies that pre-school experience rich in tactual, motor, visual and other perceptual experiences as well as a varied verbal environment would be useful in laying the groundwork for left-right awareness.

2. Since stage one left-right awareness, or ability to discriminate between right and left from the individual's own point of view, appears to be an important factor in early success in reading, an implication of this study for the classroom is that teachers should ensure that their reading readiness programs contain a number of activities involving the left-right orientation of objects in space. For example, the copying of easily reversible letters or other symbols could be used, or children could be given puzzles involving picking out the pattern that is "different" by being reversed. In addition the direct teaching of the notion of right and left should be quite easy since the concept lends itself to games of interest to the grade one child. In this way the attention of the child is drawn to the details of visual symbols and he is able to identify with ease his own lateral body parts. He learns that the orientation of objects is relevant to their meaning. The inclusion of activities involving left-right awareness may help the teacher in identifying potential reading problems and overcoming the difficulties of such children by early intensified instruction.

3. Since confusion on the Benton A has been found to be related to less accuracy in reading it could be a useful diagnostic instrument

for the reading clinician, in identifying a possible antecedent for a particular child's reading problem.

4. The normative aspects of the study are useful in so far as they indicate to the educator and clinician the typical skills of the grade one child, in left-right awareness. For example, this study shows that about two-thirds of children in grade one have achieved stage one left-right discrimination, about one quarter have achieved stage two and almost none have achieved stage three. Individuals who differ markedly from this pattern may be identified as atypical.

5. Since mixed (incomplete and crossed) dominance is associated with poorer left-right discrimination, teachers and clinicians should be on the look out for difficulties with left-right discrimination in mixed-dominant children. Possibly the mixed-dominant child could be encouraged but not forced into the preferential use of one hand. At any rate, more attention should be given to establishing directional orientation in these children.

LIMITATIONS OF THE STUDY

The findings of this study are limited by the nature of the sample. Although the sample included different socioeconomic status levels it is an urban Canadian sample and may be atypical in other respects.

The study was also limited by the age range in the sample. Conclusions about left-right discrimination are more or less limited to stage one left-right discrimination since stage two and three left-right discrimination were only present in a small number of children.

The Non-Verbal test of Directional Orientation was an experimental test. Not only does it lack established reliability but the lack of variance

found in the present sample presents difficulties in the interpretation of parametric statistics since these require normal distributions. Hence the findings with respect to this test should be regarded as tentative.

SUGGESTIONS FOR FURTHER RESEARCH

1. A follow-up study on the present sample would be an interesting indication of the longitudinal development of left-right awareness and lateral dominance as well as the relationships of these factors to reading. Such a study should reveal whether early difficulties in left-right discrimination are overcome during the course of development, whether mixed dominance is a temporary or a lasting phenomenon and whether difficulties in reading persist and/or become more serious in subjects who are confused between right and left. Also it would be interesting to determine whether subjects who were earlier in achieving stage one left-right discrimination also achieved stage two and three left-right awareness more rapidly than other children. In addition more information about the nature of stage two and three left-right awareness could be obtained.

2. A cross-sectional developmental study of several grade levels would also be useful in examining many of the questions posed in #1. In particular, more information on the nature of stage two and three left-right awareness and their relationship with reading could be attained.

3. Studies involving the application of experimental treatment to samples to find out whether left-right awareness can be improved as a result of training would be particularly pertinent to the education of children in discrimination of left and right. Similarly experimental treatment to encourage the preferential use of one side of the body

in mixed-dominant children could be attempted.

4. Attention could profitably be directed towards the refinement of the Benton scale, particularly the Benton B and C each of which contains only four items. The expansion of these subtests to include more items should help to make the test more reliable.

5. An investigation of the understanding of left and right in deaf children and blind children would be useful in determining the respective contribution of language and visual-perception to left-right awareness.

6. The connection between left-right awareness, lateral dominance and body awareness could be explored further by developing a measure of body awareness and relating it to measures of lateral dominance and left-right discrimination.

CONCLUDING STATEMENT

This study has examined the relationship of beginning reading achievement to left-right discrimination and lateral dominance. Also the relationship of left-right discrimination and lateral dominance to each other and to verbal and visual-perceptual ability were investigated. Results indicated that grade one reading achievement is related to left-right discrimination at the stage one level but not to lateral dominance, that left-right discrimination and lateral dominance are related to each other, that left-right discrimination is related to verbal and perceptual ability and that lateral dominance is related to perceptual ability but not to verbal ability. The results were interpreted as supporting Benton's view that the growth of body awareness contributes to the development of left-right discrimination. It was suggested that more attention should

be paid in the classroom to developing left-right discrimination skills in children as a preparation for learning to read.

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APPENDIX A

LATERAL DOMINANCE (FROM HARRIS TESTS)

APPENDIX A

Lateral Dominance (From Harris Tests)

Handedness:

Name _____

Age _____

Grade _____

1. Throw a ball _____
2. Wind a watch _____
3. Hammer a nail _____
4. Brush teeth _____
5. Comb hair _____
6. Turn door knob _____
7. Hold eraser _____
8. Use scissors _____
9. Cut with knife _____
10. Write _____

Name _____

Hand _____ Time _____ Sec _____

Name _____

Hand _____ Time _____ Sec _____

Footedness:

Eyedness:

Kicking _____

Stamping _____

Telescope _____

Hole _____

APPENDIX B

THE BENTON TEST OF RIGHT-LEFT DISCRIMINATION

APPENDIX B

The Benton Test of Right-Left Discrimination

Subject A:

(Subject's Eyes Open)

1. Show left hand.
2. Show right eye.
3. Show left ear.
4. Show right hand.
5. Touch left ear with left hand.
6. Touch right eye with left hand.
7. Touch right knee with right hand.
8. Touch left eye with left hand.
9. Touch right ear with left hand.
10. Touch left knee with right hand.
11. Touch right ear with right hand.
12. Touch left eye with right hand.

(Subject's Eyes Closed)

13. Show right hand.
14. Show left leg.
15. Show right eye.
16. Show left ear.
17. Touch right ear with right hand.
18. Touch left knee with right hand.
19. Touch right eye with left hand.
20. Touch left ear with left hand.
21. Touch left eye with right hand.
22. Touch left knee with left hand.
23. Touch right shoulder with left hand.
24. Touch right eye with right hand.

Section B:

1. Point to man's right eye.
2. Point to man's left leg.
3. Point to man's left ear.
4. Point to man's right hand.

Section C:

1. Put your right hand on man's left ear.
2. Put your left hand on man's left eye.
3. Put your left hand on man's right shoulder.
4. Put your right hand on man's right shoulder.

APPENDIX C

NON-VERBAL TEST OF DIRECTIONAL ORIENTATION

APPENDIX C

Non-Verbal Test of Directional Orientation

Subtest A

Name: _____ Grade: _____

Age: _____

Directions: I want you to listen carefully and do exactly what I say.Part I (use pictures)

1. Raise your hand which is on the same side of the line as the cot. _____
2. Raise your hand which is on the same side of the line as the dog. _____
3. Raise your hand which is on the same side of the line as the cow. _____
4. Raise your hand which is on the side where the girl is lying down. _____
5. Raise your hand which is on the same side of the picture as father. _____
6. Raise your hand which is on the same side of the picture as the dog. _____
- 7.. Raise your hand which is on the same side of the picture as the boy's foot. _____
8. Raise your hand which is on the same side of the picture as the horse's head. _____
9. Raise your hand which is on the side which shows the way the rabbit is looking. _____
10. Raise your hand which is on the same side as the words. _____

Subtest C

Copying of nonsense syllables - see Chapter III.

Subtest B

Directions: I want you to listen carefully and do exactly what I say.

eg. Use the same hand as I am using and touch this hand of the man.
(right hand to right hand)

1. Use the same hand as I am using and touch this leg
of the man.
(right hand to right leg)_____
2. Use the same hand as I am using and touch this leg
of the man.
(right hand to left leg)_____
3. Use_____using and touch this hand
of the man.
(left hand to left hand)_____
4. Use_____using and touch this eye
of the man.
(left hand to right eye)_____
5. Use_____using and touch this
ear of the man.
(right hand to left ear)_____
6. Use_____using and touch this
eye of the man.
(left hand to left eye)_____
7. Use_____using and touch this shoulder
of the man.
(left hand to right shoulder)_____
8. Use_____using and touch this shoulder
of the man.
(right hand to right shoulder)_____

APPENDIX D

TABLE OF RAW SCORES

TABLE OF RAW SCORES

Subject	Age (mths)	Benton Tot.	Non-Verbal Total	Neale	W.I.S.C. Vocab.	Frostig Total
1	79	16	22	20	23	50
2	81	6	22	12	19	53
3	85	17	22	18	16	57
4	79	20	24	20	5	53
5	86	4	25	5	18	57
6	82	30	22	30	26	66
7	86	6	22	5	17	51
8	85	24	25	27	18	58
9	88	30	22	23	17	58
10	81	29	24	23	14	54
11	87	23	22	25	31	68
12	84	21	27	21	18	63
13	84	24	28	20	21	51
14	86	21	28	12	16	40
15	87	24	22	26	18	52
16	85	24	22	23	14	44
17	79	1	22	29	19	61
18	89	29	22	10	20	51
19	80	9	20	10	8	51
20	86	30	29	7	17	46

Subject	Age (Mths)	Benton Tot.	Non-Verbal Total	Neale	W.I.S.C. Vocab.	Frostig Total
21	99	9	24	6	9	45
22	84	17	27	20	18	71
23	85	32	30	27	17	65
24	83	24	26	21	24	65
25	86	29	30	23	25	69
26	78	11	13	7	12	41
27	84	14	22	9	11	35
28	96	27	21	8	19	52
29	92	25	24	8	14	43
30	91	23	22	10	14	41
31	90	8	21	11	11	41
32	81	30	22	19	19	69
33	84	24	29	13	20	55
34	79	25	28	14	13	61
35	99	29	25	29	15	69
36	81	23	28	18	15	56
37	84	28	22	8	9	60
38	81	24	22	16	16	53
39	79	11	22	10	17	53
40	82	30	23	10	13	63
41	81	5	28	15	32	62
42	89	23	24	19	17	54
43	86	23	26	26	19	59
44	82	22	22	18	24	52
45	78	25	26	25	19	66

Subject	Age (mths)	Benton Tot.	Non-Verbal Total	Neale	W.I.S.C. Vocab.	Frostig Total
46	79	19	26	18	19	65
47	77	26	24	27	23	42
48	83	7	21	27	23	50
49	78	27	22	18	14	56
50	78	29	22	4	8	39
51	77	17	22	34	19	69
52	82	24	22	30	16	57
53	81	18	22	19	15	50
54	86	23	26	23	14	50
55	81	24	22	38	19	68
56	80	5	22	26	19	49
57	82	3	26	21	17	64
58	88	6	30	17	25	60
59	78	19	22	5	21	49
60	78	25	26	20	17	32

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